The Materials Outlook

Despite sporadic soft spots, business has entered the new year in anticipated form. . . . Backlogs, carried over from last fall, have contributed to the activity and give every prospect of high operations for some months yet to come. . . . Trend of all production indices is skyward except as strikes may interfere. . . . In this connection, coal and Chrysler disputes that came to a head last month provide the only major discordant note in an otherwise satisfactory score. . . . Demand for seasonal merchandise continues strong and is reflected in secondary lines. . . . This points up several influences currently at work in the overall picture. . . . First, the increased confidence over that prevailing a year ago; second, the improved market positions due to current sustained buying and last year's curtailment of output and inventory reduction; and third, the strong support accorded to virtually all business by the phenomenal construction boom currently under way. . . . This last factor cannot be overestimated. . . . Residential and commercial building reached unprecedented volume last fall, and the unseasonably mild weather prevailing locally throughout the nation through the winter months allowed the momentum to continue unabated. . . . And the effects have been felt clear across the board.

Steel producers, working into the backlogs left from last fall's strike, are cautiously estimating what they will have to spend to maintain their producing facilities in the years immediately ahead. . . . Best guesses range from three to four billion dollars. . . . Leading expenses include development of wholly new ore mines, activities involved in treatment of taconites, beneficiation of coking coal, control of sulfur, better handling of industrial wastes to avoid continued stream and atmosphere contamination, and by no means least, the new demands for pensions and social benefits. . . . Expenses of rehabilitation, modernization and expansion have totaled 2½ billion dollars since the war. . . . But there is still a lot to be done. . . . Biggest question remains: Where is the money coming from? . . . Most logical source, risk capital supplied by investors, is limited by Government tax structure. . . . Borrowing or financing from earnings only other alternatives. . . . But, and it's a big but, there must be some earnings left after taxes with which to work.

And speaking of steel, the much-heralded "turbo-hearth" process is expected to become an increasingly important addition to the industry's operating facilities in near future. . . . Sponsored by Carnegie-Illinois, the new method is claimed to be capable of making open-hearth quality steel in twelve minutes without using external fuel. . . . Present open-hearth heats average about six hours. . . . Standard basic pig is used in the process and oxygen can be added to further speed production. . . . Steels, thus produced, contain a minimum of sulfur, phosphorus, nitrogen, and other undesirable elements.

Latest communique from the titanium interests centers on the development of a titanium alloy expected to have an ultimate tensile strength of 200,000 psi.; 185,000 psi. yield strength (0.2% offset); 7% elongation; and 0.165 lb. per cu. in. density. . . . Alloy will contain about 3% chromium plus other elements. . . . Battelle is spearheading the research. . . . On strength-weight ratio basis, alloy is claimed to be better than most highly alloyed steel. . . . In general, attitude of titanium researchers reflects increased optimism as development continues.

(Continued on page 4)

The Materials Outlook *(Continued)*

New stainless steel powders have been developed to supplant previous types which were limited by poor compactibility and difficulty of pressing into intricate shapes. . . . Superiority of new powders reflected best in high green strength valves which have been raised approximately 10 times. . . . Chemical analysis of new powders parallels that of standard chromium and chromium-nickel steels. . . . Parts prepared from new powder have high mechanical strength and corrosion resistance, thus portending an appreciably wider field of powder metal applications.

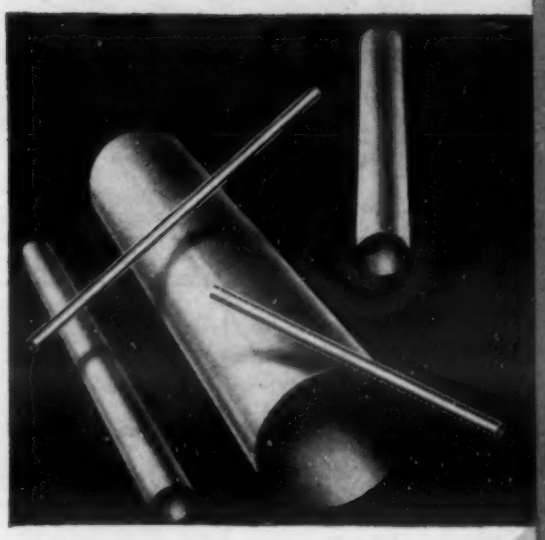
And one final note on steel. . . . According to sources close to the Capitol, the basing point system, insofar as steel is concerned, will be permitted shortly if the FTC has its way. . . . In the meantime, certain Washingtonian elements are striving to clarify the entire basing point picture and to bring order out of the organized confusion that currently surrounds the issue on the Hill.

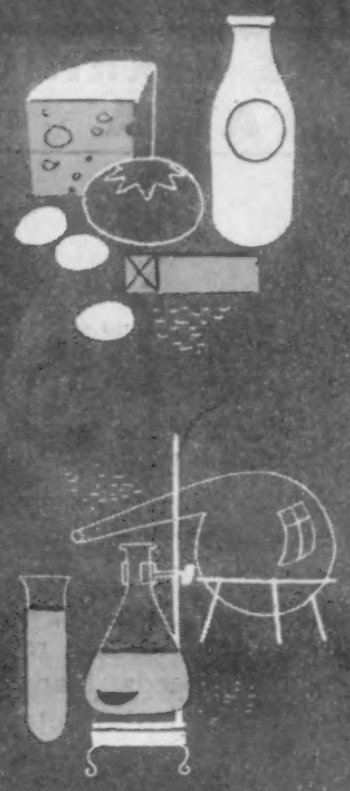
And while mentioning advantages obtained through use of alternative materials, plastics should not be overlooked. . . . The strides made in the use of these versatile compositions are little short of amazing . . . and, again, there apparently isn't any stopping point. . . . Newest applications range from foot-powder applicators to gasket-cutters, and include floor tiles, refrigerator defrosters, swizzle sticks, umbrellas, pin ball machines, cupboard door facings, slide rules, and crib bumpers. . . . The phenolics, styrenes and polyethylenes appear to be getting the biggest play, but the vinyls are running a close second.

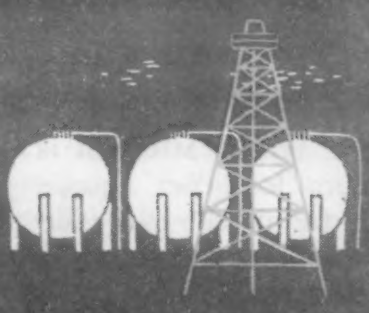
While titanium has been holding attention at the center of the stage, another relative newcomer, zirconium, has been pushing hard to get into the act. . . . Bureau of Mines' pilot plants now produce the metal in 150-lb. ingots at $6.82 per lb. . . . and the output can be raised without too much difficulty. . . . In comparing future costs of zirconium and titanium, it is believed that the higher cost of zirconium in the ore will be more than compensated by the higher consumption of reducing agent for titanium. . . . This, plus the fact that production methods of the two metals are practically identical, portends an eventual future price of zirconium on a level with that of titanium.

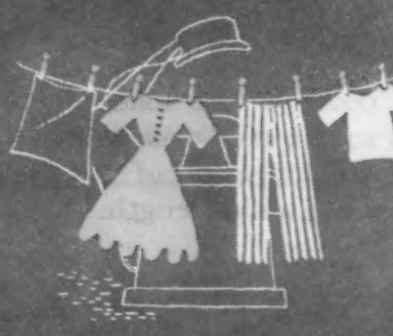
Continued expansion of light metal applications has spurred research for alloys of these metals with better physicals. . . . Notable among such work is the progress made with magnesium and various of the rare earths. . . . These little-known elements have been found to enhance in varying degree the strength, hardness and creep resistance of magnesium at room and elevated temperatures. . . . For instance, considerably higher elevated temperature properties can be developed in magnesium-didymium and magnesium-cerium-free Mischmetal alloys than those exhibited by magnesium-Mischmetal alloys alone. . . . But the superiority may not hold over entire temperature range. . . . Even so, certain advantages may warrant their future use for commercial applications. . . . But a lot will depend upon the availability of the rare earths, and a possible reduction in their cost.

Speaking of high temperature alloys, the nickel-chromium combinations are attracting increasing attention in the aircraft industry for components in gas turbines. . . . In Europe, alloys of the Nimonic series are the standard materials for the moving blades of all turbines. . . . Over here, Inconel "X" is usually used for rotor disks and other parts. . . . These alloys should also be useful for other high temperature applications such as reaction chambers, bolts, bellows, springs, etc. in handling high temperature steam or chemical process fluids.









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JOHNSON

SLEEVE BEARING DATA

Bearing DESIGN

BRONZE

SLEEVE BEARING DATA

Standard Tests for Sleeve Bearings-1

IN the selection of the proper type of Sleeve Bearing for any given application there are certain fundamental steps to follow before arriving at the final decision. The first move is to determine, as near as possible, the operating requirements such as speeds, loads, shock, temperature, lubrication, etc. The next step is to compare, by certain known and accepted tests, which bearing *material* will meet these requirements in the most satisfactory manner. Samples of the various materials, each produced to the same size and thickness are then used so that each test is comparative. Thus by matching the operating requirements of the application to the physical properties of the bearing material we arrive at a satisfactory selection of the proper bearing to use.

In determining the physical properties of bearing materials we use the following tests:

Tensile Strength

The ultimate tensile strength is the maximum load per square inch the material will carry up to the point of rupture. It is really a test of toughness.

Yield Point

The yield point is the load in pounds per square inch necessary to produce an elongation of .2% of the original specified length.

Elongation

This property is expressed as the percentage of length increase, after test piece has been ruptured, divided by the original specified length. This test is an indication of the material's conformability property and in addition indicates to a certain degree the shock resisting capacity of the material.

Johnson Bronze Alloy No.	PHYSICAL PROPERTIES				
	Tensile lb. per sq. in. ±5000	Proportional Limit ±2000	Yield Point lb. per sq. in. ±3000	Elongation per cent in 2 in.	Brinell Hardness No.
19	27,500	7,800	20,700	8±4	62
25	22,500	6,900	16,750	11±4	44
27	30,000	9,700	19,000	10±5	58
29	24,000	7,600	16,400	9±4	52
51	36,500	12,500	18,500	15±5	67
53	36,000	13,000	19,000	18±4	69
55	39,200	13,600	21,000	10±5	74
66	26,000	7,800	14,500	12±5	48
71	29,000	8,200	16,500	20±7	49
72	29,000	8,600	14,600	17±5	56

A typical listing and comparison of various popular, cast bronze bearing alloys.

Reduction of Area

This property is determined by measuring the decrease which occurs in the cross sectional area of the specimen at the point of rupture, as compared to the original diameter of the test piece. This property is also expressed as a percentage.

Hardness

Hardness can be determined in several ways, with the Brinell and the Rockwell methods being the most popular in non-ferrous materials. In determining the Brinell hardness number we use a 10 millimeter ball and apply a 500 kilogram load for a period of thirty seconds. Hardness is, in fact, an indication of the material's resistance to deformation, which also indicates the compressive strength of the material.

Compressive Strength

This test establishes the percent of permanent deformation occurring under specified loads. It is figured in relation to the size and form of the specimen used for testing.

●

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

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SLEEVE BEARING HEADQUARTERS

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PREVIEW

Fourth National Plastics Exposition

The most recent technical developments and the newest applications of plastics will go on display in Chicago's Navy Pier when more than 100 of the leading producers and manufacturers of plastics exhibit at the Fourth National Plastics Exposition, March 28-31.

The Exhibits

The huge exhibit halls of Navy Pier will be filled with plastics items ranging from automotive parts to dog collars. There will be displays of industrial parts, electrical appliances, housewares and hardware, packaging, sporting goods, automotive parts and accessories, and radio and television parts and cabinets.

The exhibit hall will be open on Tuesday and Thursday from 1 p.m. to 10 p.m., and on Wednesday and Friday from 1 p.m. to 6 p.m.

The Exposition is open to the trade only. Exhibitors are sending out invitations to interested parties, so that the bulk of those attending will be buyers and users of plastics.

Case-History Displays

Highlighting the exposition will be an exhibit of more than 100 case histories of the plastics uses by every major industry or product group classification illustrating how plastics have been utilized to improve appearance, obtain greater durability, lower production costs, and increase value.

Featured in the case-history display, sponsored by the Society of the Plastics Industry, will be two 1950 automobiles illustrating the places in which plastics have been employed. These two cars each average more than 14 lb. of plastics, compared to a use of only 7½ lb. on the 1941 models. New refrigerators will also be compared to the old models, pointing out that one 1950 model now uses 24 lb. of plastics in 68 parts; while the 1940 model had only plastics knobs and door-liners.

The story of the development of the modern telephone handset, now completely made of plastics, will be illustrated, showing how plastics gradually replaced other materials. Some other typical plastics applications will show molded phenolic parts in vending machines, housings for power mowers, laminated bearing surfaces in heavy machine tools, plastics (tetrafluorethylene) covers on bread-molding machine rolls, urea and nylon gears and wheels in adding machines, plastics gaskets in machines needing chemical-resistant parts, and phenolic-molded water valves that have replaced castings.

The wide variety of plastics in the packaging field will also be illustrated, contrasting the former containers with the new materials. Plastic uses in toys, electrical insulation, washing machines, air conditioner grilles, electric sweepers, and building materials will also be shown.

Plastics Conference

Two meetings have been scheduled during the week by the Society of the Plastics Industry. Both sessions will be concerned with market development, sales, and promotion of plastics. Two of the topics covered will be "Sales by Design," and "Selling—The Plastics Industry's Number One Job." The meetings will be held at the Stevens Hotel the mornings of March 28 and 29.

The annual Exposition banquet has been tentatively set for the evening of Wednesday, March 29. The affair will be held at the Stevens Hotel.

INFORMATION IN BRIEF

Exposition Site	*Navy Pier, Chicago*
Dates	*March 28 through 31*
Hours	
Tuesday & Thursday	*1:00 p.m. to 10:00 p.m.*
Wednesday & Friday	*1:00 p.m. to 6:00 p.m.*
National Plastics Conference	*Hotel Stevens*
	Tuesday & Wednesday Mornings
Banquet	*Hotel Stevens*
	Wednesday Evening

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Improving present products?

Designing brand new ones?

Trying to cut costs?

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"Picture-in-a-minute . . . because we erased a century of habit-itis"

says
J. H. Booth
Exec. Vice Pres.
Polaroid Corporation

"We had to side-step the conventional, and banish a hundred years of 'habit-thinking' in our industry to even *envision* a camera that takes a picture, develops and prints it in less than a minute," continues Mr. Booth. "Once done, however, our course was clear. Our direction and purpose, research and design, methods and materials—all were free of the bonds of conventionality . . . and the new Land camera was born."

Two Monsanto plastics help make Polaroid's sensational, fast-selling camera a functional success. The spool on which negative film is wound is made of durable, easily-molded Lustrex styrene—it completely eliminates the danger of light damage that Polaroid found present with conventional metal spools. Secondly, through the use of Monsanto's vinyl butyral, components of Polaroid's unique self-developing film were effectively protected from moisture.

Monsanto's broad range of plastics have remarkably versatile properties that hundreds of manufacturers have found adapted to their product needs. Perhaps *your* products could be improved with lighter weight, or greater toughness, or lustrous, longer-lasting colors. Perhaps they could be produced at lower cost, with more pieces per material-pound and with fast, one-shot plastic moldings that eliminate costly assemblies. Investigate the great variety of properties of Monsanto's many plastics. Lustrex: Reg. U. S. Pat. Off.

Monsanto Chemical Co., Plastics Div., Dept. MMP-27
Springfield 2, Mass.

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Name & Title _____

Company _____

Products Manufactured _____

Address _____

City, Zone, State _____

List of Exhibitors

4th National Plastics Exposition • Navy Pier, Chicago, March 28-31, 1950

Exhibitor	*Booth Number*
American Cyanamid Co.	231
American Molding Powder & Chemical Corp.	147
American Wheelabrator & Equipment Corp.	170
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Celanese Corp. of America	252
Central Die Casting & Mfg. Co., Inc.	237
Central States Steel Boiler Co.	161
Chicago Molded Products Corp.	242
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Conforming Matrix Corp.	259
Creative Plastics Corp.	249
Crown Machine & Tool Co.	251
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The Dow Chemical Co.	101
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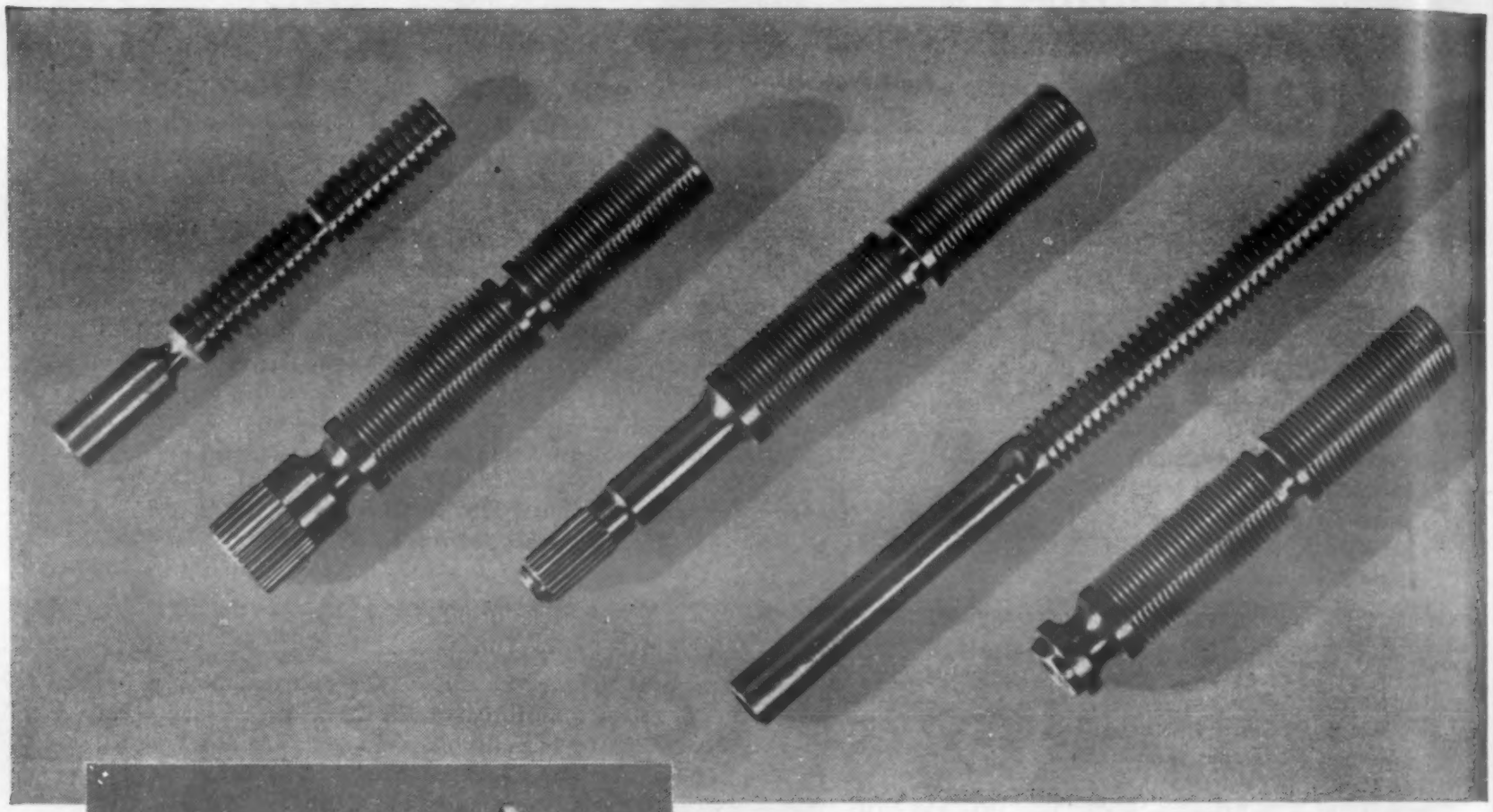
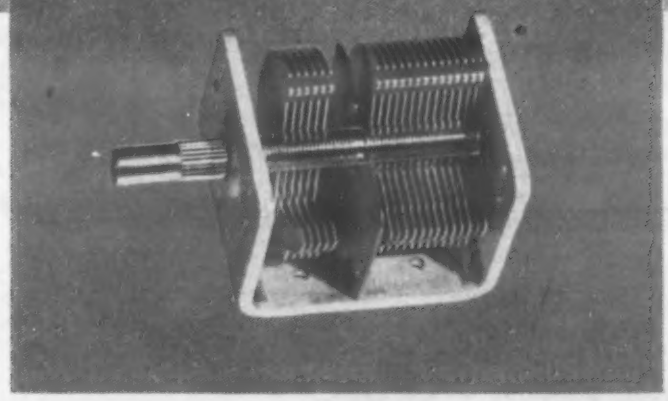
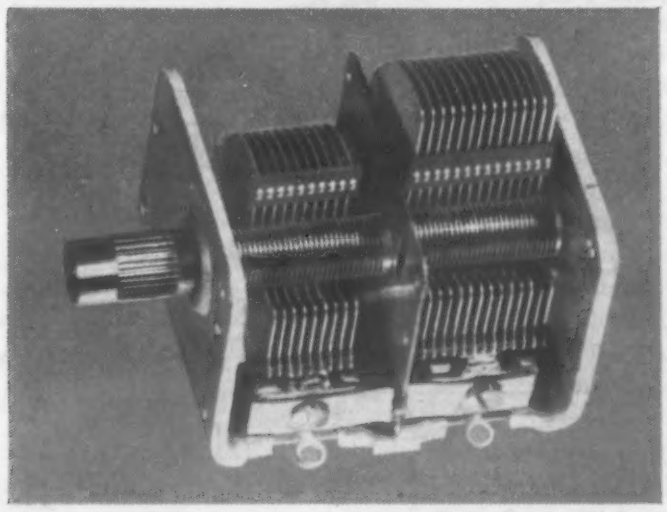
For Tough Machining Jobs, Get REVERE FREE-CUTTING BRASS







Above, Model CS, smallest condenser, air space .009". Below, Model B, largest, air space .013". Rotor shafts, shown in top illustration, are Revere Free-Cutting Brass, plates aluminum. Made by The American Steel Package Co., Defiance, Ohio, an important supplier to the electronics industry.

HERE are several examples of the fact that Revere Free-Cutting Brass is really good. These rotor shafts for variable condensers are cut on automatic machines at 3600 r.p.m. Circular tools are used to cut the concentric slots which are .050" deep. Only one cut has to be taken. Approximately 425 pieces are produced per hour on a 6-second cycle. The American Steel Package Company, Defiance, Ohio, produces a number of different condenser models, with air spacing ranging from .009" up to .042". The slots in the shaft of Revere Free-Cutting Brass are all of the same width, regardless of air spacing, namely .014" plus or minus .0002". It takes good machines, good tools, good men, and good metal to work that closely. A report from a Revere Technical Advisor who had collaborated with the company states: "Customer is outstanding in his praise of Revere Rod." . . . If you have a problem in the machining of brass, why not give Revere an opportunity to work with you? The Revere Technical Advisory Service is at your command.

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News Digest

Survey Reveals Wide Use of Plastics in Product Manufacture

There are many indications that the novelty appeal of plastics has begun to wear off. As this trend continues, the materials specifier may be expected to assume an increasingly rational, even cautious, approach to the use of plastics. In addition to considering the advantages of plastics offered by their lightness, shock resistance, flexibility, corrosion resistance and often their transparency, he will be forced to become even more conscious of their important limitations, namely their generally low strength, low abrasion resistance and poor heat resistance.

But the production experience of the last decade has proved that plastics can compete successfully with metals, glass and other older materials for innumerable applications. It is not surprising, therefore, that the market for plastics is still an expanding one, and nowhere is this more true than in that segment of the manufacturing economy known as the metalworking industries.

Market Research Survey

About three years ago, the market research department of MATERIALS & METHODS conducted a survey to determine the extent to which plastics were being used in some of the leading metalworking industries. Questionnaires were mailed to M&M subscribers in industrial plants manufacturing the following products:

- Automotive products and parts
- Aircraft, engines and parts
- Railway equipment and rolling stock
- Ships, boats and marine equipment
- Contract-manufactured parts and assemblies
- Electrical equipment and appliances
- Light machines and instruments
- Heavy machinery and machine tools
- Building products and equipment
- Cutlery, tools and hardware
- Ordnance
- Jewelry and novelties

Also interviewed were consulting engineers and firms. The questionnaire elicited a 26% return.

The results indicated that, at the time of the survey, about 70% of the plants covered used plastics in fabricating their products. In addition, nearly 4½% more plants registered their intention of adopting plastics in the near future. Molded plastics were the most popular form used by these plants, with sheet, laminates, machined parts, extruded parts, raw material resins and castings also used, in that order of frequency. The average plant was using three or more different forms. About 84% of the plastics users were buying fabricated plastics parts and 31% were molding, laminating or casting parts; 15% were both buying and fabricating plastics parts.

Some Users Dissatisfied

On the other hand, nearly 15% of the plants covered by the survey had abandoned plastics in favor of other materials. Among the reasons most frequently advanced for discontinuing the use of plastics were (1) lack of dimensional stability, (2) lack of strength, (3) service failures, (4) cost considerations, and (5) technical superiority of another material.

Of widest general interest are the figures showing the proportions of plastics users (70%), potential users (4½%), and former or dissatisfied users (15%). The validity of these results, of course, rests upon the not unreasonable assumption that the plants represented by M&M subscribers are a fair cross-section of the industries covered, and upon a percentage of returns which would be considered excellent by most market research organizations.

Nevertheless, during a period of rapid technological advances, three years is a long time. Certain factors which have been operating over the intervening period must be taken into consideration before the information obtained in this earlier survey can be construed as a true picture of the situation today.

Changes Have Been Made

The recent technical advances in the plastics field will not be reviewed here; passing allusion to the development of more thermally stable materials and improvement of fabricating techniques should suffice as indications of an upward trend. Plastics are not suitable as structural members, but this indictment must be coupled with the realization that, in the industries specified above, structural members represent only a fraction of the material requirements. According to the best available information, supplied for the most part by the Society of the Plastics Industry, Inc., there is every reason to suppose that the proportion of plastics users in these metalworking industries is now closer to 85% than 70%.

Similarly, a survey today would probably show that considerably fewer manufacturers are finding it necessary to discontinue the use of plastics. It must be remembered that the conditions existing immediately following the war and, in fact, until quite recently were those of a "sellers'

News Digest

market"; the war-inflated demand resulted in many fabricated plastic parts of poor or inconsistent quality.

Inadequate Evaluation

In fairness to the plastics industry, however, it must be reported that its customers in the metalworking industries did not always properly evaluate these plastics. In their eagerness to exploit the novel and economic features of these materials, they sometimes neglected to analyze their laboratory testing procedures or, worse, failed to consider adequately the important service limitations of plastics. This irrational approach has been largely eliminated by a subsequent educational program conducted by the plastics industry and the technical press. In short, higher quality resins and more careful evaluation have made more satisfied customers.

As to the potential market for plastics still existing in these metalworking industries, any specific estimate at this time would be hazardous. The continuing interest which materials specifiers in these plants have shown in plastics, however, is a good indication that the well is not yet dry.

Continuous Quality Control Indicator Checks Reject Rates

An electric computor which keeps an automatic, continuous check on reject rates in manufacturing operations and makes possible the location and remedy of abnormal production difficulties as quickly as they occur, has been introduced by General Electric Co. G.E. engineers believe this quality control indicator can be instrumental in reducing manufacturing costs, at the same time assuring the highest possible quality of most mass-produced items.

The indicating equipment need not be set up near the production line, but may be installed in the office of supervisory personnel. It can be used to control quality not only of finished products but of materials and parts and forms before fabrication or assembly.

This bank of meters in the General Electric Co.'s Erie, Pa., Works shows up excessive reject rates along refrigerator assembly lines.

In the past, statistical analysis of production and rejection rates has been made by time-consuming computations, lagging behind production by hours or days. Such a lag often makes it possible for an abnormally-high rejection rate to go undetected, resulting in considerable manufacturing losses. The new instrument, which counts the number of items produced and the number rejected, is designed to eliminate this lag by indicating whether the percentage of rejections is above or below an acceptable level at any given instant.

The device uses a signal, such as an electric eye or a switch tripped by passing articles, to count the number of units produced. Every time an inspector rejects a unit, he pushes a button which causes a change of reading on the indicating meter. When the reject level at an inspection station exceeds a pre-determined rate, the needle on the meter moves from the green half of the scale to the red half, indicating to supervisors that corrective action is needed.

The basic equipment consists of two units: a "totalizer," which counts the units inspected, and a "characteristic analyzer," which counts the rejects for a given characteristic checked by inspectors. In general, it is necessary to use only one totalizer for each production line, and a characteristic analyzer for each characteristic being checked.

Additional Steel Capacity

A 15-month program of plant improvements, designed to increase the production of cold-reduced sheets by about 200,000 tons a year in the Chicago district, was announced recently by Carnegie-Illinois Steel Corp., a United States Steel subsidiary. The modernization will be carried out at the slabbing mill and the sheet and tin mill in Gary, Ind.

New Award Program Established for Die Casting Achievement

An award program for the die casting industry has been set up recently by the American Die Casting Institute. The program provides for a cash award of at least $500 and an appropriate plaque to be presented each year to the individual or related group of individuals making the most noteworthy contribution to the die casting industry.

The three main areas of activity which will be considered by the Award Committee are technical achievements, advancements in plant operations, and activities in the field of public relations.

Recipients of the award will be selected by the Board of Directors of the Institute. Entries must be submitted to the Institute, 366 Madison Ave., New York 17, between Jan. 1 and April 1; the award will be made each fall, starting next September.

Known as the American Die Casting Institute—Annual Doehler Award, the presentation has been made possible by a special fund donated by Doehler-Jarvis Corp.

New Research Facilities

Expanded facilities for research in the field of chemicals, ceramic materials, metals and alloys, electrode coatings and refined ores are contained in laboratories opened recently by Foote Mineral Co. in Berwyn, Pa. The new three-story building, housing a staff of 35 scientists and technicians, has been equipped to carry out basic research as well as product development and engineering studies related to improvement in equipment design and process control.

News Digest

Variety of Research Projects Promises Improved Materials, Broad Technological Advances

An occasional glance at the research of today often provides the materials engineer with useful fore-knowledge of the new products and materials of tomorrow. Accordingly, in the paragraphs below, a few of the research projects in progress at one of this country's largest independent research organizations are brought to the attention of M&M readers. They have been selected from the 1949 Annual Report of the Armour Research Foundation of the Illinois Institute of Technology.

Stress Analysis Methods

Corresponding with growing interest in the causes of service failures in metals is the development of improved methods of stress analysis. Following the development of an inexpensive wide-field diffused-light polariscope which largely eliminates the necessity for long and careful lens adjustments, a method is being developed to utilize creep phenomena to "freeze" an elastic pattern in the specimens.

In addition to photoelastic methods, improvements are being sought in brittle materials and coatings used for stress analysis. The brittle material method consists basically of applying known load increments to a full-scale plaster model of the component under study, noting the load which causes failure and the point of origin of failure, and relating the results to corresponding loads and stresses in structural materials. The older method of analyzing surface stresses by means of a brittle coating is also being studied with a view toward developing a coating material more insensitive to temperature and humidity and having greater crack sensitivity and linearity.

Alloy System Studies

Investigations of the relationship between tri-axial stresses and the failure of metals have been aided considerably through use of a new material for test specimens in which initial brittleness is a function of temperature. By controlling the temperature, the effect is obtained of testing different materials having different degrees of inherent brittleness, thus permitting an evaluation of the effect of this property on the failure of the material.

Among the alloy systems studied recently was that based on molybdenum and containing chromium. In addition to lattice parameter determinations, tests on oxidation resistance up to 1800 F, forgeability and hot hardness up to 1600 F were run. Results seem to indicate that these molybdenum-chromium alloys offer promise for high-strength, high-temperature applications, provided a satisfactory method is developed to protect them from oxidation.

The casting characteristics and mechanical properties of aluminum-beryllium alloys were also studied. These alloys show promise for certain instrument applications in which light weight, high modulus of elasticity and high strength at moderate temperatures are important. A program undertaken more recently will study the structural changes in titanium-base alloys resulting from heat treatment.

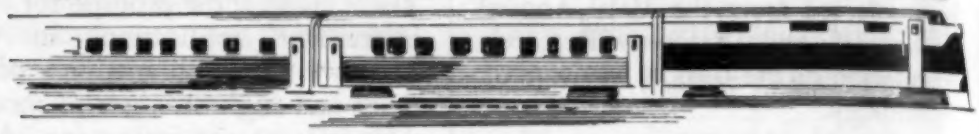
Other Current Programs

Other investigations of special interest include: use of molybdenum to overcome temper brittleness in chromium and managanese steels; in-

(Continued on page 112)

Inland HI-STEEL

makes your product lighter, stronger, longer lasting



REDUCE WEIGHT

Because its high strength-to-weight ratio permits use of lighter sections, HI-STEEL makes possible important reductions in dead-weight. Less steel is needed per unit, enabling material savings up to 25%.

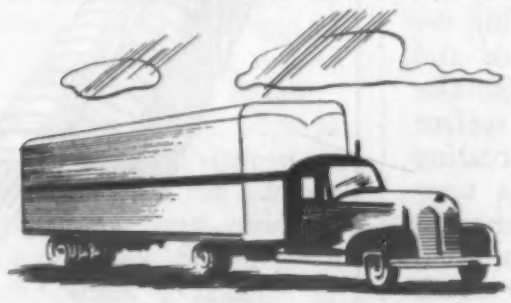
INCREASE STRENGTH

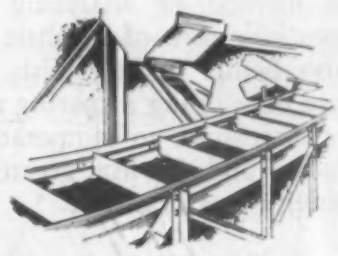
High strength, low alloy HI-STEEL has nearly twice the yield strength of ordinary structural-grade carbon steel. It is also superior in notch toughness, fatigue strength and abrasion resistance. Because of its high strength-to-weight ratio, HI-STEEL provides greater strength with the same sectional thickness.

INCREASE LIFE

HI-STEEL lasts longer on the job. Its tight scale resists atmospheric corrosion four to five times as long as ordinary structural-grade carbon steel. It has been known to resist 12 times as much abrasion as ordinary structural-grade steel.

And Inland HI-STEEL is easy to fabricate. It can be worked either hot or cold—punched, drawn, or otherwise fabricated—welded or riveted—with little or no change in shop practice.





COMPARISON OF *AVERAGE* PROPERTIES OF HI-STEEL WITH ORDINARY STRUCTURAL GRADE CARBON STEEL

Tensile Properties (¼" Plate)	Inland HI-STEEL	Ordinary Structural Grade Carbon Steel
Yield Point (psi)	56,000	35,000
Ultimate Strength (psi)	73,000	66,000
Elong. in 8" (%)	25	25
Endurance Limit		
Fatigue Strength (psi)	49,000	33,000
Impact Resistance (Charpy Impact—ft. lbs.) Temperature		
80° F	55	36
32° F	43	33
0° F	36	26
—25° F	34	6
—50° F	30	2

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Plastics vs. Metals In Engineering Applications

by WILLIAM SCHACK*

The constant search for suitable applications of plastics has led to their successful adoption in many cases where engineering properties as well as cost are of primary importance.

• IN ANY DISCUSSION of the relative merits of plastics and metals, comparisons must be made primarily on the basis of engineering qualities and economic considerations. In the past, some metals men have been inclined to lightly dismiss plastics because of its small production volume compared to such metals as steel. While it is true that the 750,000-ton annual production of plastics is quite small along side of steel's annual volume of 85 million tons, this is not a valid criterion by which to judge an engineering material. And, seeing the growing number of applications in which plastics have replaced metals, it has become evident that comparisons must be made on the basis of engineering properties and cost.

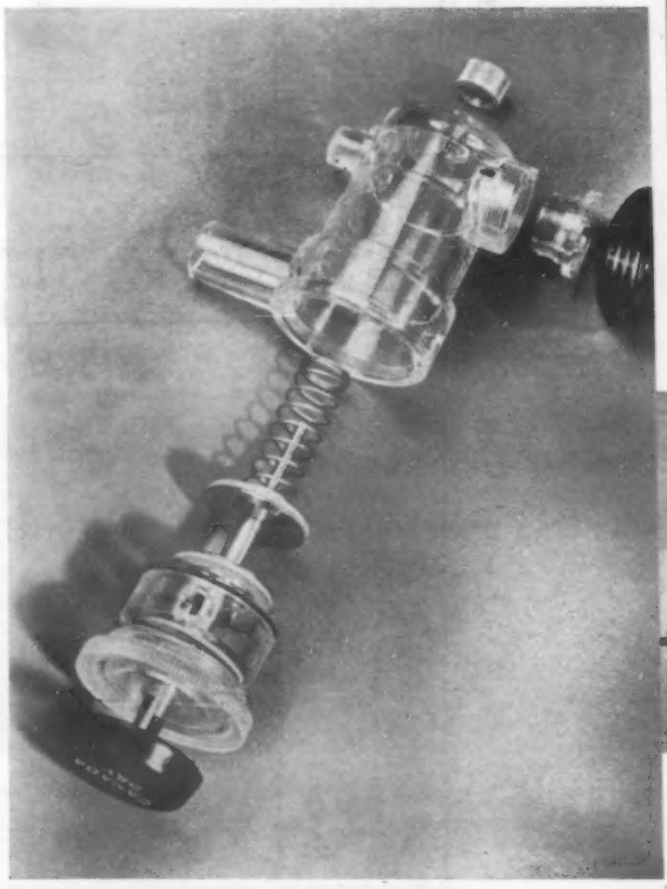
On this basis, it seems clear that in their major fields of use the metals will retain their position indefinitely, that plastics are displacing them only on specific products by product evaluation, and that there is a considerable area of application in which they complement each other.

Properties Compared

The characteristics which, singly or in combination, commend plastics, and in which they are superior to metals are low density, dielectric strength and other electrical properties, low thermal conductivity, high damping capacity, "built-in" color (as opposed to the surface finishes of metals) and, in the thermoplastics, an unlimited range of color. This much is shown in the accompanying table prepared by Robert G. Chollar, of the National Cash Register Co., in his study for the A.S.T.M. of the relationship of plastics and metals in reference to business machines. Other important properties the metals do not have, and which are limited to only a few plastics, are transparency and extreme chemical resistivity.

The comparative cost data in the table indicate that in material costs plastics are usually higher than metals, although not as much higher as is often believed. Initial material costs, however, do not always give the entire picture. For example, a major factor which cannot very well be tabulated is the ease of manufacture of plastics parts, which, in volume production, makes for low unit cost. It is not merely a question of reproducing a design which might, technically, be carried out in metal or some other material. The economy made possible by plastics is often due to the simplification of design or the redesign they call for. The Magnus chromatic harmonica, for example, has only 14 molded plastic components as compared to the 159 metal and wood parts of an equivalent instrument in those materials.

The points of superiority of metals as a class are also indicated in the table. They have higher mechanical strength and higher moduli of elasticity, less thermal expansion, lower cold flow, greater heat resistance and hardness, and lower water absorption. Not shown in the table is another valuable property not possessed by the plastics—the capacity to be treated for localized changes in properties.



Exploded view of dispenser unit which takes full advantage of plastics' properties.

To a certain degree it is obvious that a great many applications will fall exclusively to either plastics or metals where one or more properties

* *Mr. Schack is editor of the forthcoming "Plastics Encyclopedia"*

Comparison of Plastics and Metal Properties

	Specific Gravity	Comparative[c] Cost	Comparative Hardness	Comparative[d] Shock Resistance	Tensile Strength, Psi.	Thermal Exp., 10^{-5} per Deg. C.	Therm. Cond. 10^{-4} Cal./Sec./Sq. Cm./Deg. C./Cm.	Heat Distortion at 264 Psi., Deg. F	Dielectric Strength, V. per Mil.	Modulus of Elast., Psi. x 10^5	Damping Capacity	Def. under Load of 4000 Psi. at 122 F, 24 Hr., %	Water Absorption, 24 Hr., %	Color Possibilities
Phenolics (Molded)	1.4	5-10	45	1-33	5,000-12,000	3.0	4-7	275	250-400	7-15	High	0.4	0.4-2	Limited
Phenolics (Laminated)	1.4	18-24	33	3-48	5,000-15,000	1.5	5-8	>325	200-700	7-30	High	Low	1-4	Limited
Glass Laminates	1.7	33-40	40	25-130	40,000-50,000	0.6	3-5	>320	450-650	20-25	High	Low	0.3-0.6	Limited
Ureas	1.5	10-14	48	1.0	5,000-13,000	3.0	7.0	275	300-500	12-15	High	0.55	1-3	Unlimited
Vinyl Chloride-Acetates	1.4	16-23	18	1-2	6,000-10,000	6.9	4.0	130	400	4	High	1.20[a]	0.1	Unlimited
Methyl Methacrylates	1.2	28	26	1-2	6,000-10,000	8.0	4-6	140-200	500	3-6	High	2-12	0.4	Unlimited
Polystyrene	1.1	9-14	20	1-2	5,000-9,000	7.0	2-3	160-180	500-700	2-6	High	0.5-5	0-0.05	Unlimited
Polyamide (Nylon)	1.1	53	26	4-6	7,000-10,000	10.0	6.0	170	375	3-4	High	4.0	1.5	Unlimited
Cellulosics	1.2	14-24	10	2-38	2,000-10,000	12.0	4-8	110-215	250-600	0.5-4	High	1-65[a]	1-6	Unlimited
Steels	7.8	1-17	120-800	17-300	40,000-250,000	1.26	1,150	1000[b]	Conductor	280	Low	Nil	0	External applications
Aluminum and Heat Treatable Alloys	2.7	5-8	30-115	8-65	13,000-76,000	2.40	48,000	460[b]	Conductor	103	—	Nil	0	External applications
Magnesium and Alloys	1.7	—	40-95	3-30	20,000-48,000	1.43	2,500	450[b]	Conductor	65	Intermediate	Nil	0	External applications
Zinc and Alloys	7.1	4-5	70-100	105-140	30,000-52,000	2.63	2,700	—	Conductor	124	—	Nil	0	External applications

[a] *Extreme deformation characteristics of material required test method revision to 1600 psi. load for 6 hr.*
[b] *Above these temperatures physical properties drop rapidly.*
[c] *1 represents lowest cost.*
[d] *1 represents best shock resistance.*

in which they excel are called for. In electrical uses, the metals play an exclusive role as conductors, the plastics as non-conductors; and, in this case, their roles are complementary. But the properties as shown in the table are not sufficient unto themselves. They must be interpreted in the light of the function and service requirements of the specific application. Thus, the low thermal conductivity of plastics is in their favor in such applications as handles for coffee pots and other heated vessels, but it is a critical handicap for bearings that heat up under load and at high speeds. On the other hand, the low modulus, which is plastics' chief disadvantage as compared to metals in structural applications, is a desirable property in gear designs where silent operation is important and excessive heating does not take place. Here, the low modulus is correlated with high resiliency.

Further, it has been pointed out by H. M. Quackenbos, of the Bakelite Div., Union Carbide & Carbon Corp., that the apparent relative weakness and low modulus of plastics must be qualified: "If a plastic part is designed to be as strong as a steel part by providing more material, it will often be as stiff as the steel part. This is particularly true in flexural loading, where capacity for load depends on the square of the depth and stiffness varies as the cube of the depth." That is to say, if the plastic part is made strong enough, it will have sufficient stiffness.

The manner of application of stress is another design factor which is not reflected in the table of properties. Stresses applied quickly to plastics and removed quickly usually have a less permanent damaging effect than much smaller stresses applied for long periods of time, whereas the reverse is true of those metals which fatigue easily.

Again, with regard to damping characteristics, specific design must be taken into consideration. On the one hand, increasing uncontrolled stress due to vibration may cause low-damping metals to reach their fatigue strength and fail when plastics would not. On the other hand, high damping qualities also produce internal heat, and the low thermal conductivity of plastics, together with the fact that their properties are more affected by heat than are those of metals, may count against them. Broadly speaking, where their superior damping qualities more than compensate for their low fatigue strength, plastics can be used effectively. That is the case in aircraft members which are subject to vibration-inducing forces.

Case Histories

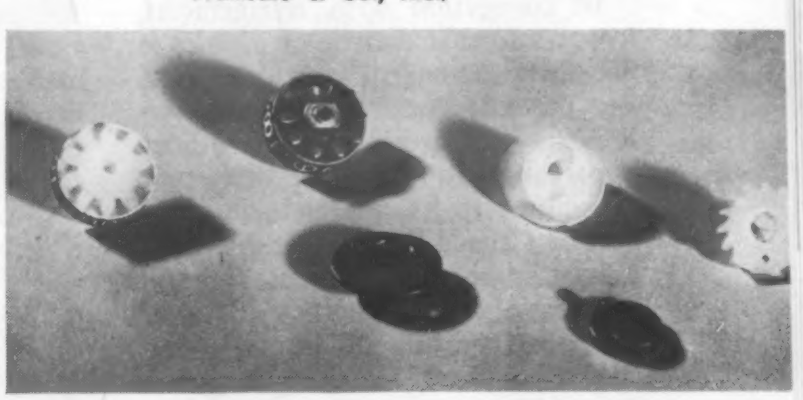
Turning now from these general considerations, let us survey a number of concrete applications in which plastics have replaced metals. This has been most striking in the field of refrigerator design. The Norge model of 1935 contained 1 lb. of plastics, almost entirely phenolic components; the 1949 model has 41 different plastic parts weighing 12 lb. A high-pressure laminate replaced porcelained sheet steel in the inner door liner because it saved weight (5 lb. against 13 lb.), was a heat insulator and could be fabricated more quickly. For the same reasons, the evaporator door was made of polystyrene in place of porcelain enameled steel. The tank blocks, which act as supports between the outer steel shell and the inner tank, used to be made of a combination of wood and metal. They were difficult to fabricate, permitted heat losses and did not stand up under the repeated shocks to which they were subject during shipment and service.

Various plastics have been found to be superior. A number of plastics have also been used in place of the stainless steel lock-bolt rollers. They showed marked wear in time because they could not be sufficiently lubricated at assembly to last the life of the refrigerator. One manufacturer who supplies this part found that nylon rollers did not require any lubrication and did not show any signs of wear after 500,000 cycles of opening and closing. Since they also cost from 15 to 35% less, he made nylon the standard material for this component and has used it in some 300,000 assemblies. Without calling the roll of all the components which have gone over to plastics, it may be said that they have replaced sheet steel, aluminum, plated metal, die castings, wood and rubber. One other comment is pertinent. The extensive use of plastics in refrigerators is not a matter of greater economy, part for part, but, as one engineer put it, a matter of improving their performance and appearance without adding to their cost.

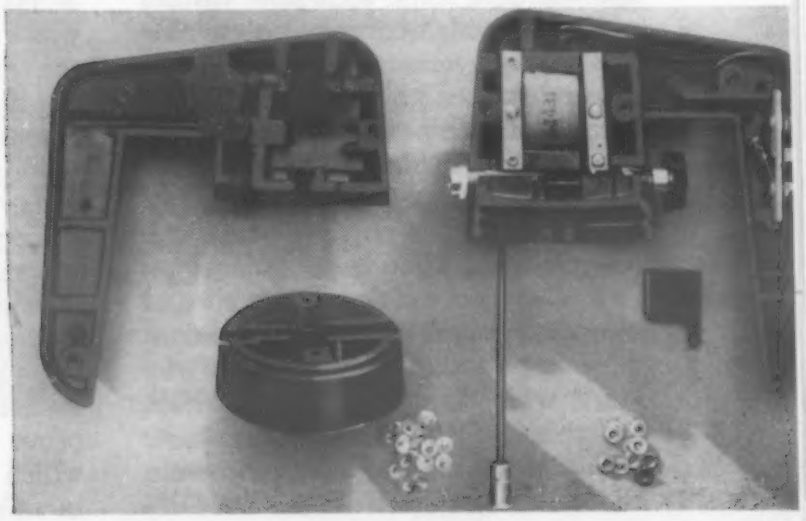
The history of the design of telephone equipment also reflects a

Some nylon plastic parts (white) used on Monroe calculator. Two of these replaced three metal parts (black); one is a new part. (Courtesy E. I. du Pont de Nemours & Co., Inc.)

This battery ignition coil is an excellent example of how metals and plastics can be combined to good advantage.



A cross-sectional view of a paint sprayer molded of a phenolic in a single piece. (Courtesy Durez Plastics & Chemicals, Inc.)



steady and varied use of plastics. To speak only of the end component—the speaking apparatus in home and office—the most striking change is the conversion from a die cast to a plastic housing for the base of the handset type. In the latest Model 500, injection molded cellulose acetate butyrate is specified for this part, with cellulose propionate as an alternate. While these do not have as good dimensional stability as metal, they are satisfactory in this respect in the given design, and they are superior in two important factors: They retain their excellent initial surface finish; and they greatly simplify fabrication and installation. The signal bell does not have to be mounted on the wall in a separate box, but is contained in the base. It should be noted, however, that metal is not entirely discarded. It is still a highly important component as the sub-base on which the working parts are mounted. The plastic is simply a cover for the base and mount for the handset and dial.

Simplified fabrication and improved appearance are also evident in the redesigned functional part of the Burgess sprayer (see accompanying figure). The cross-sectional view, with its bosses and recesses molded in a single phenolic piece, suggests the complex assembly operations which were eliminated.

In connection with refrigerators, it was said that the use of plastics is not always attended with lower cost. But there are cases where such savings are considerable and sometimes remarkable. In the syrup dispenser distributed to its dealers in the past year by Canada Dry Ginger Ale, Inc., it is estimated that the incorporation of plastic components in place of metal resulted in a cut in production cost of at least 40%. Figuring the cost of the actual unit at about $10, the savings on the 50,000 dispensers installed in the first year alone amounted to some $330,000. Instead of sheet metal, a cover of polystyrene was used to eliminate the need for repairs caused by dents (in the metal) and chipping off of the surface finish. The plastic, too, is notably cheaper and more attractive, in two colors: the upper portion, white; the lower, dark green.

The two are molded separately and cemented together. The major economy was in the components of the valve, which is screwed into the hub, and this is set on an aluminum base. On other models, the valve parts were all of stainless steel. In the new design, stem, bushing, gasket backing washers and a nut are still made of this material, but clear acrylic plastic is used for the large body, sleeve, end plug and adapter bushing. These were molded by General Electric Co.'s Plastics Division. Not only are these molded parts more economical—they are more easily assembled and disassembled; they are easy to clean with warm water, and they look better.

The plastic parts required six molds, one of them a combination mold producing two parts. Their initial cost was $35,000. Written off on the first run of parts, the cost per unit now comes to about $7. The new syrup dispenser uses plastic parts also employed in other models—polyethylene gaskets and phenolic screw cap and stem knob.

A few "simple" plastic substitutions for metal made a sharp cut in costs in another dispensing device—an automatic popsicle vending machine said to be the first of its kind. Eastern Engineering & Sales, Inc., the Philadelphia company which designed and produces this Kenro machine, saved more than $300 per unit by incorporating eight phenolic bushings (costing 6¢ each) in place of bronze bushings (costing $1.20 each), and four phenolic ring units in place of aluminum ones. These rings, 15¾ in. in dia., are a kind of Ferris wheel with 180 ice-cream bars for passengers. Fabricated in aluminum, it was a complex production and assembly job. In phenolic, the complexity is all in the design of the two phenolic parts which, assembled to a spider, constitute one of the four-ring assemblies required. Each of these cost $38 less than the aluminum ring. The consequent weight reduction of 30 lb. also reduced shipping costs. Still another economy was effected in tooling cost by replacing the curved metal top of the front door by acrylic. The metal piece would have required an outlay of $7,000. In plastic, the shallow curve was a simple forming operation and the set-up cost only $150. The 0.187-in. thick red plastic sheet is also more decorative.

In a Monroe calculating machine costs were reduced 67% and more lasting service obtained by redesigning the correlated ratchets, counting dials and cams in nylon. In the production of the dials, ten production steps were eliminated; in that of the cam, 20; and it was possible to improve the intricate ratchet design, which was practicable to mold only in nylon. The plastic parts are held to tolerances of 0.0015 in.; they have much higher wear and abrasion resistance than metal, and do not have to be lubricated (which also necessitated the cleaning of the dials); and they operate more quietly and smoothly.

Space is not available for further case histories, but the range of plastic replacements of metals can be further indicated by the mere mention of polystyrene in place of aluminum in a General Electric clock back, the Pierceway molded phenolic conduit, butyrate tubing in beverage and saran tubing in chemical transfer lines, molded polyethylene connectors in high frequency cable assemblies, and acrylic chemical pump parts.

On the other side, there have been switches from plastics to metals. During the war there was considerable demand for plastic architectural trim because of the shortage of aluminum. Thermoplastics which had sufficient resiliency were required, and they were later largely abandoned because they did not have sufficient dimensional stability under changing humidity and temperature conditions.

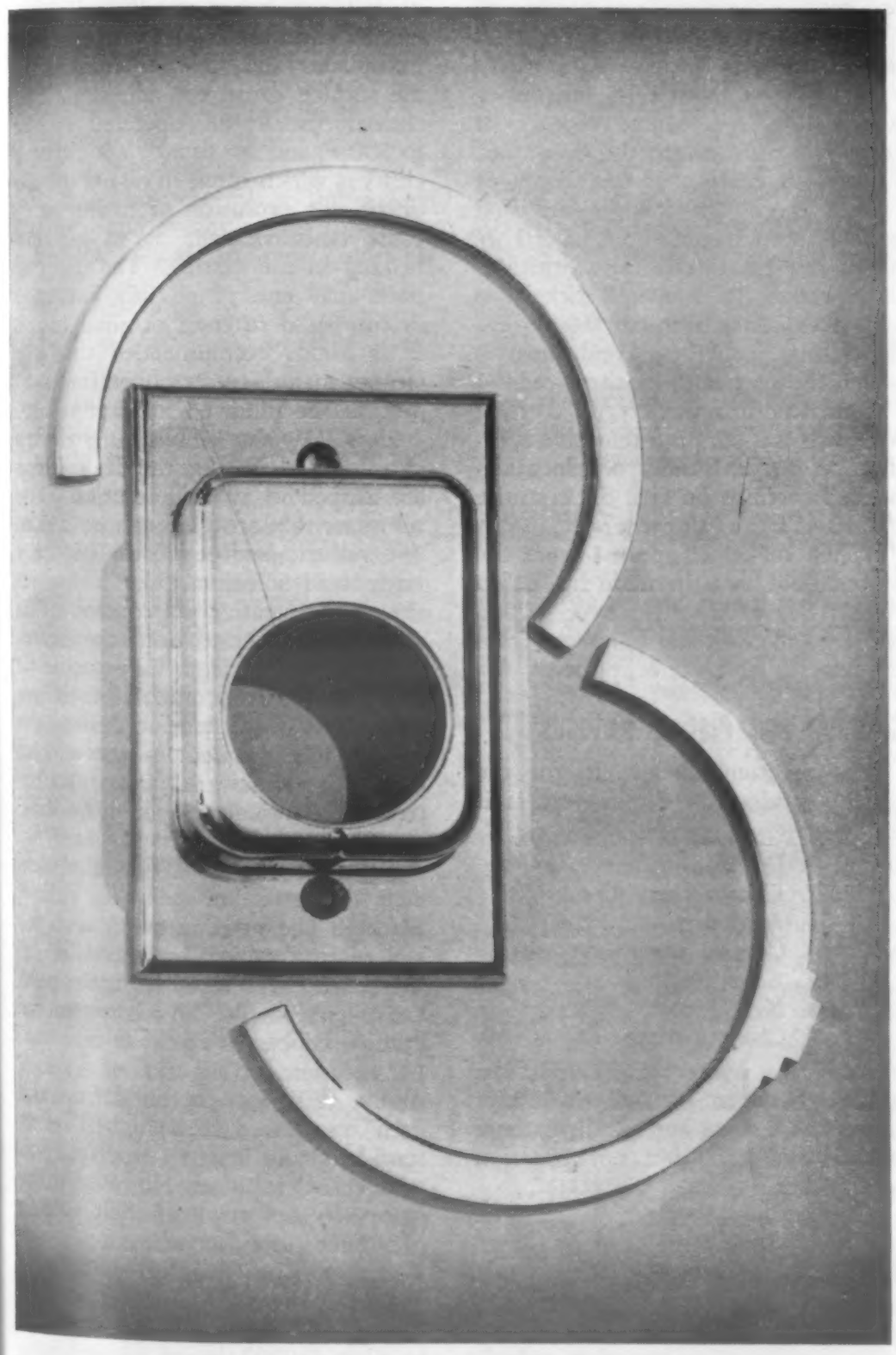
Mention was made early in this article of the applications in which plastics and metals can be combined, and reference was made later on to electrical wiring and the telephone base. Another happy union is exemplified in plugs and other connectors in which phenolic or urea-formaldehyde act as the dielectric and die cast housings act as a mechanical support. Some automobile instrument panels are molded in plastic and have die cast parts applied; others are die cast, with plastic elements applied. The combination of the two groups of materials in electric range panels is also familiar.

As a final example, a striking case can be cited. It is the recently designed battery ignition coil of International Harvester Co. Here an asbestos-filled phenolic serves as the electrical insulator for the primary and secondary terminals—a conventional function. What is different is the manner of production and assembly, which results in the plastic serving as a pressure-tight seal. The phenolic component is first molded to the steel cans. Then the coil assembly is inserted and the two cans welded together. Oil is run in through holes in the inserts, which are then closed with solder. According to the molder, Shaw Insulator Co., this is the first time that plastics have been molded to metals to achieve a pressure-tight seal.

Methods of Plating Zinc-Base Die Castings

Design, careful surface preparation, and proper choice of plating cycle are all important considerations for successful plating of nickel or chromium.

by ROBERT L. BUCKLEY, Industrial Chemical & Equipment Co.



These die castings were given a final flash plate of 24-karat gold after being nickel plated. (Courtesy Brown & Bigelow, Inc.)

● ONE OF THE FIRST considerations in the design and production of metal parts is the means by which they can be finished. In the case of zinc-base die castings, the zinc metal surface is very reactive and does not retain a lustrous finish unless covered with a suitable finish. Plated coatings of nickel or chromium are, therefore, frequently used. Nickel can be deposited to give a lustrous, highly reflective plate and is usually followed by a thin deposit of chromium to retain the high luster.

For successful plating of zinc-base die castings, several important considerations must be kept in mind. These include design of the die casting, surface preparation prior to plating, and the plating process.

Design of Die Castings

In too many cases, the metal finishing department is not consulted or considered when the matter of design is discussed or planned. This, of course, is not true in every case, but when it does happen it often results in serious problems in the metal finishing department. For instance, in designing a die casting which will have a plated finish, flat surfaces should be avoided wherever possible. Flat surfaces tend to show up or magnify imperfections in the base metal, and this often requires much more polishing and buffing than if a slight radius was incorporated.

Sharp corners should also be avoided. The alloy is, in itself, soft enough and the pressure exerted by a polishing wheel often draws or pulls those corners, causing rejects. If there is to be plating of adequate thickness, consideration should be given to recesses, as they often make polishing or buffing impossible, thus resulting in a loss of luster and color in the recessed areas.

Common defects which cause considerable difficulty to the metal finisher working with die castings are excessive shrinkage, embedded lubricant, porosity, cold shuts and parting lines. It is known that die castings shrink a certain degree after standing, but the actual effect of a metal deposit on the die casting is not known. Porosity and cold shuts cause an excessive amount of unnecessary polishing and this excessive polishing is often detrimental, as will be shown later. Parting lines require polishing to reduce them to the casting dimensions and their location, if possible, should be limited to nonsignificant areas. Embedded lubricant presents a problem mainly in cleaning prior to plating as its presence will yield a nonadherent deposit.

Surface Preparation

The plated deposit, especially in decorative work, is only as satisfactory as the condition of the base metal on which it is applied. Therefore, zinc die castings in most cases require a considerable amount of polishing and buffing prior to the plating cycle. The first consideration should be to remove as little metal as possible. Polishing is usually done with conventional polishing wheels impregnated with grit of the desired size. The size may range from 50 to 300, depending upon the finish desired and the condition of the base metal. Abrasive belts are now being used very largely for the polishing operation. Buffing is accomplished by using soft muslin buffs impregnated with the desired composition.

In the case of porous castings, extreme care should be taken in the polishing operation as excessive polishing will cut through the dense outer die cast skin to the soft inner structure, making the subsequent cleaning and polishing operations difficult by exposing the more porous surface, often yielding non-adherence to the deposit. Buffing and polishing also may close a portion of the pores or cold-shut areas, entrapping buffing composition or other materials which will cause non-adhesion to the deposit applied later.

Plating

Watt's nickel or bright nickel cannot be applied directly to the die casting as a dark, non-adherent deposit results. This is also true with chromium, which cannot be applied to die castings directly. There is a special nickel solution containing a high sulfate content which does make it possible to apply a nickel deposit directly to zinc die castings. There are, however, certain disadvantages to the solution which will be mentioned later. In most cases, a film of copper is deposited from a cyanide solution followed by the nickel and chromium.

Deposit Thickness in In.

	Type QZ	Type KZ	Type FZ
Copper and Nickel	0.0005 in.	0.00075 in.	0.00125 in.
Copper, Min.	0.0002 in.	0.0003 in.	0.0004 in.
Nickel, Min.	0.0003 in.	0.0003 in.	0.0003 in.
Chromium, if Used	0.00001 in.	0.00001 in.	0.00001 in.

Type "QZ" is for indoor use, "KZ" indoor and limited outdoor, and "FZ" outdoor use.

The thickness of the copper over the base varies widely. Most firms apply at least 0.0002 in. of copper, which allows a sufficient thickness of copper to diffuse into the outer zinc surface. A coating of 0.0001 in. of copper is enough for the diffusion which results plus another 0.0001 in. of copper for safety. The thickness of subsequently deposited nickel can vary from 0.0003 in. to 0.0008 in., depending upon the conditions to which the part is to be subjected.

The American Society for Testing Materials has set up a tentative specification for thickness of electrodeposited coatings on zinc die castings, (B142-45T), as shown above.

When nickel is applied from the high sulfate bath the main limitation is that heavy deposits (over 0.0005 in.) tend to crack and pull away from the base to which it is applied.

Cleaning and Plating Methods

The recommended cycle for the plating of zinc-base die castings is as follows:

1. Precleaning
2. Electro cleaning
3. Acid dip
4. Copper plate
5. Acid dip
6. Nickel plate
7. Chrome plate

Adequate water rinsing must be utilized between each of the above steps. If the rinse water is dirty, there is a chance for solution contamination resulting in rejects.

Precleaning—Precleaning may be carried out in any one of many forms. The most common and efficient one is the use of solvent vapor degreasing using trichlorethylene. The solvent dip-spray-vapor condensation cycle is most highly recommended as it removes almost all greases, oils, insolubles and other foreign matter from the die casting.

Electro Cleaning—Alkaline cleaners, in most cases, are required to remove little soil as the greatest portion is removed in the precleaning. Pyrophosphate cleaners should be used in preference to silicated cleaners. Silicates are harder to rinse than phosphates and, if they remain on the surface, cause non-adhesion. The cleaners usually are operated at 150 to 180 F, and are usually anodic type cleaners which result in no deposition of zinc or evolution of hydrogen to cause embrittlement or to get imbedded in the casting. The die cast parts may emerge slightly darkened as compared to their original luster. It is highly recommended that the cleaner manufacturer's operating suggestions be followed for best results.

Acid Dipping—Following electro cleaning and rinsing, the die castings are dipped in an acid solution. The solutions that are used can be a 3 to 5% sulfuric acid or a 5 to 10% muriatic acid solution. The former is slower but easier to control. The parts are immersed until the evolution of gas is noticed. Care should be taken so that too much time is not allowed as it will tend to destroy the anodic film formed in the electro cleaning. Stoneware jars or rubber covered equipment should be used for the acid solutions.

Copper Plating—After the acid etch, the parts are ready for copper plating. The procedures for the copper plating cycle vary according to the facilities. In some cases, the parts are given a "strike" in a conventional cyanide copper or Rochelle type copper solution for a period of ½ to 2 min. at fairly low current density and then transferred to a higher speed, semi-bright or bright (proprietary in most cases) solution. However, many firms accomplish all of their plating of copper in the Rochelle copper solution in which, if carefully controlled, a light-colored, closely grained copper deposit may result. It is possible to plate 0.0002 in. of copper from the Rochelle-type copper bath in 3½ to 4 min. using 40 amp. per sq.

ft. This bath is operated at 140 to 150 F, 20 to 60 amp. per sq. ft. at 2 to 3 v. The metallic copper content should be maintained at 2.5 oz. per gal. and the free cyanide content of 0.75 oz. per gal. The pH is kept in the range of 12.2 to 12.8 (colorimetric). There are addition agents available which, when added to the Rochelle-type of solution, will give greater efficiency and a lighter colored deposit.

Acid Dipping—A 1% sulfuric acid dip should follow the copper plate to neutralize any alkaline materials that may not have been rinsed off. Muriatic acid should not be used as the possibility of a portion of it being carried into the nickel solution to follow will result in an increase in the chloride content of the nickel electrolyte.

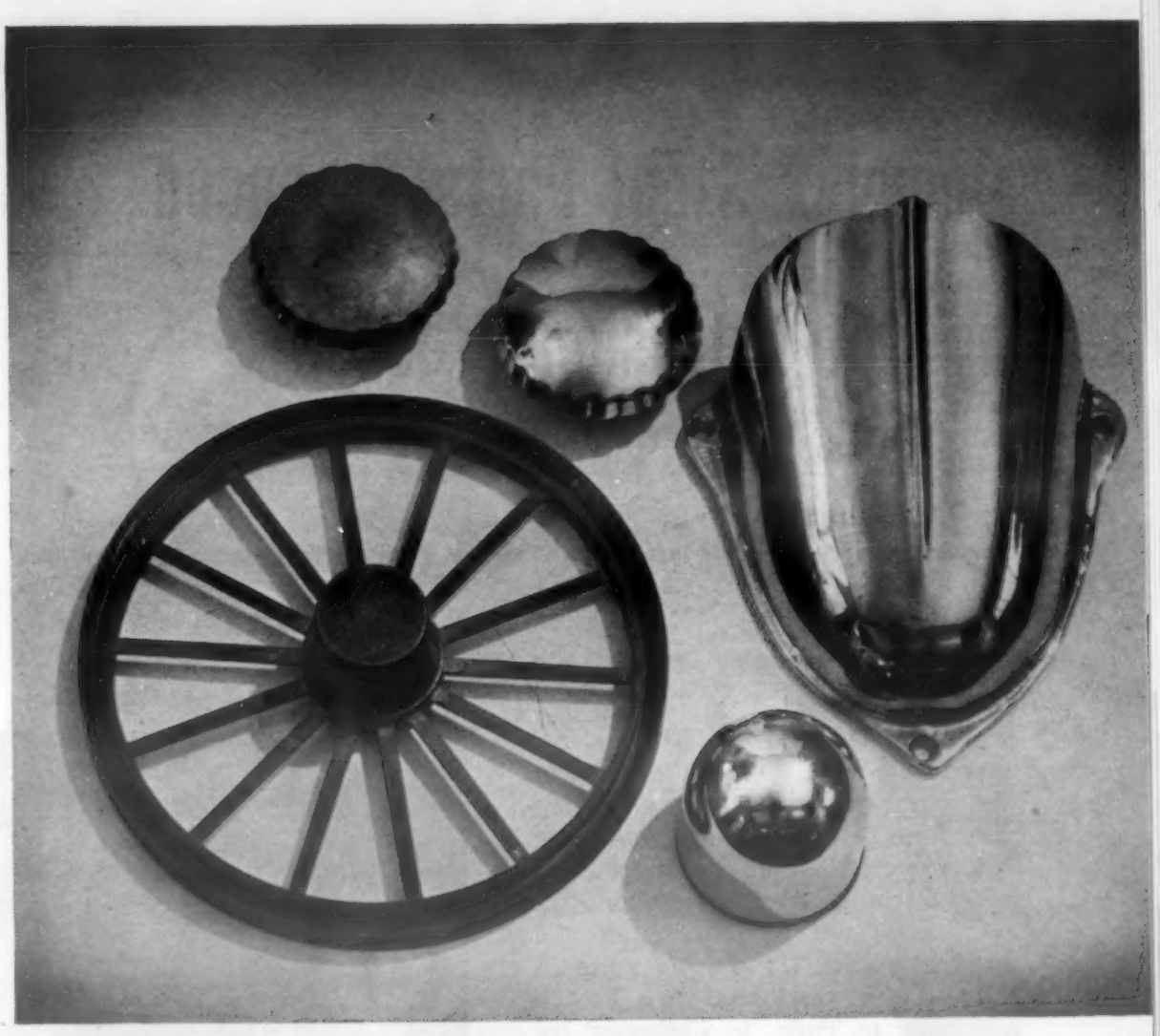
Nickel Plating—When the die cast parts have been copper plated and rinsed followed by the recommended acid dip, they are ready for nickel plating. The bright nickel solutions in the industry are the most common for this purpose. Most of the bright nickels, of the organic type, are primarily the Watt's type nickel solution as follows:

Nickel sulfate	32 to 45 oz. per gal.
Nickel chloride	6 to 9 oz. per gal.
Boric acid	5 to 7 oz. per gal.

To these solutions certain agents have been added to yield a smaller grained, bright deposit possessing high reflectivity plus wetting agents, anti-pitting agents, etc. The solutions usually operate at 110 to 135 F, 20 to 80 amp. per sq. ft. A pH range of 3.5 to 5.0, electrometric, should be maintained through the use of sulfuric acid to lower the pH, and nickel carbonate to raise the pH. A deposit of 0.0003-in. nickel can be accomplished in the above solution in approximately 7½ min. at 50 amp. per sq. ft.

Chromium Plating—The final deposit, that of chromium, is applied following the nickel plate. The standard decorative or bright chromium bath is utilized. A thickness of 0.00001 in. can be deposited in 1.1 min. at 200 amp. per sq. ft. with the ratio of chromic acid to sulfate at 100:1.

It must be remembered that all rinses and solutions should be maintained as clean as possible. Tanks should be cleaned daily when plating die castings; the presence of zinc as an impurity in most cases will render poor deposits, causing rejects. Normal methods of solution purification should be followed regularly.



Some miscellaneous zinc die castings finished in chromium with the exception of the wheel, which is finished in the usual manner for copper plating, oxidizing, and final relieving and lacquering. Shown at upper left is a part before being plated.

Direct Nickel Plates

If one wishes to employ the high sulfate nickel solution to plate the nickel over the zinc die casting and not have to employ the copper undercoat, the following solution is suggested:

Nickel sulfate	10 to 15 oz. per gal.
Sodium sulfate (anhyd.)	10 to 15 oz. per gal.
Ammonium chloride	2 to 6 oz. per gal.
Boric acid	1 to 3 oz. per gal.

This bath is operated at room temperature and 10 to 40 amp. per sq. ft., depending on the operating characteristics of the solution. The pH should be maintained at 4.9 to 5.7, electrometric, using sodium hydroxide to increase and hydrochloric acid to lower the pH.

It should be remembered that this bath is not designed to yield satisfactory deposits for thicknesses of over 0.0005-in. nickel; cracking and pulling may result over the above deposit thickness. If necessary the work can be plated in a Watt's-type solution after an initial film of nickel has been deposited in the higher sulfate bath if thicker deposits are required.

The same precleaning and electro cleaning steps should be followed for the nickel-nickel as for copper-nickel plating.

Barrel Plating

When zinc die cast parts have been polished by the normal tumbling methods, the following cycle should be followed:

1. Alkaline clean
2. Copper plate (Rochelle-type copper solution)
3. Ball burnish
4. Alkaline clean
5. Nickel plate in the following solution:

Nickel sulfate	15 to 30 oz. per gal.
Nickel chloride	3 to 6 oz. per gal.
Boric acid	1.5 to 3.0 oz. per gal.
Sodium borate	0.5 to 1.5 oz. per gal.
Ammonium hydroxide	5 to 10 oz. per gal.

The solution can be operated at 90 to 140 F and a pH of 7.0 to 7.5 electrometric. Commercial barrel bright nickel solutions usually can be used in place of the above if desired, in which case the manufacturer should be consulted for operating conditions.

Complex Steel Parts Produced by Hot Extrusion Process

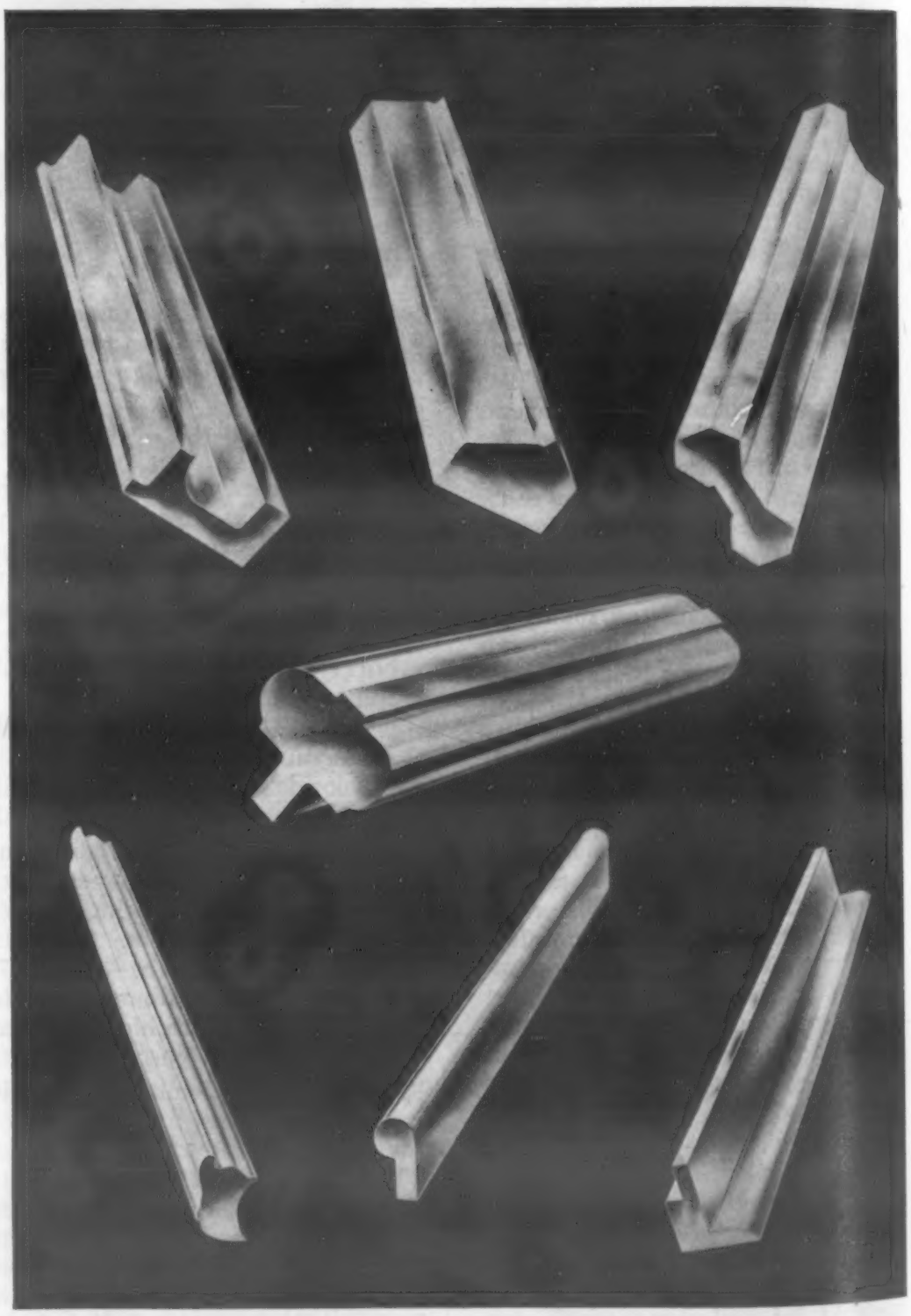
Recent extension of hot extrusion process to steel makes possible forming of alloy parts with high and uniform strength properties.

by J. SEJOURNET,
General Manager, Comptoir Industriel d'Etirage et Profilage de Metaux, Persan, France

● FOR MORE THAN 30 years research has been carried on all over the world to find a way of extruding the ferrous alloys, whose working temperatures exceed by more than 600 F those of the most difficult nonferrous metals, red copper and bronze. About 1940 this research competition was joined by a French company in Paris, le Comptoir Industriel d'Etirage et Profilage de Metaux (CIE), subsidiary of the Societe d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine. This company's work culminated in the completion of a steel extrusion plant in Persan and the beginning of manufacturing operations in January, 1949.

In the year that has passed since the plant was opened, hot steel extrusion has shown itself to be not only perfectly feasible and without technical surprises, but even much more productive than had been previously assumed. For example, the output of the Persan plant is five times greater than the tonnage that had been estimated when the plant was built. In addition, the experience of a year of commercial production has enabled CIE engineers to constantly widen the range of applications of steel extrusion. The accompanying sketches and photographs illustrate just a few of the many different steel sections produced thus far.

An important advantage of the process is the ease of forming steel of highly-varied analyses; some of the groups of steels successfully formed are molybdenum stainless steels, refractory alloys, creep-resisting alloys, high-speed steels, chromium-carbon tool steels and bearing steels. Thus,



Some typical hot extruded solid bar shapes. Finished product has high mechanical properties.

the process offers a method of fabricating alloys difficult to roll or forge. Other favorable features, summarized briefly, are high and uniform mechanical properties, little waste of metal, low tooling cost and extreme flexibility. Ultimately, these characteristics make possible cheaper production of complex parts.

Process Development

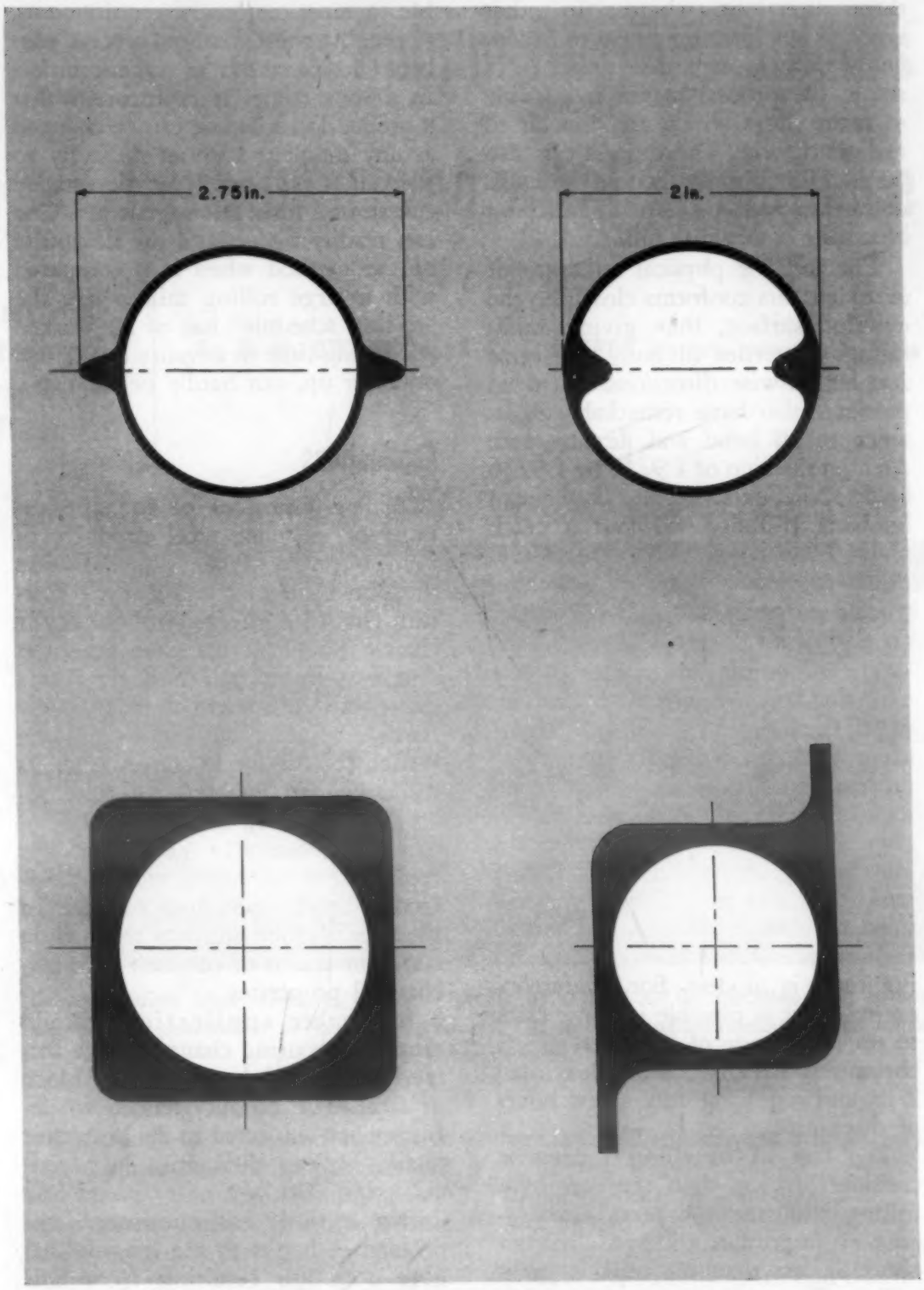
The hot forming of nonferrous metals by extrusion has developed in recent years in proportions that never would have been expected by those who years ago first extruded lead. This process is now used for the direct transformation of cast ingots into bars, tubes and wire, and is applied to a great number of alloys.

In nonferrous extrusion, the raw metal is used in the form of round ingots as-cast or sometimes turned, according to needs, and of diameters that vary from about 2¾ in. for small 300-ton presses up to 16 in. for the large 4000-ton presses. The length of the ingot varies from 8 to 32 in., according to the amount of reduction of the section or the capacity of the hydraulic press.

The ingot is first heated up to the desired temperature in a furnace. It is then placed in a hollow cylinder or "holder" made of high-speed steel capable of resisting the high pressures involved. At one end the holder is closed by a die, the opening of which has the profile of the cross-section of the bar that is to be produced. At the other end, pressures varying from 85,000 to 170,000 psi. are applied by means of a punch according to requirements. Under this pressure the metal is extruded through the die, resulting in a profiled bar. At the end of the operation there remains in the holder a short length of ingot, called the butt, which is sawed off and removed. In making a tube, a rod centered in the punch pierces the ingot which is then forced to flow between the pierce and the round die to form a hollow bar.

For a number of years CIE was accustomed to working nonferrous metals by extrusion on a small 600-ton press. The company specialized in producing extremely complicated shapes and had, accordingly, developed a highly perfected extrusion technique. Both technical and economic factors seemed to justify the extension of extrusion to steel.

It rapidly became apparent to CIE engineers that the problem to be solved was not so much a problem



Tubular sections of unusual design can be produced by the hot extrusion method. Ribs or fins on tube as shown above make possible an increase in moment of inertia while reducing weight.

of resistance of the steel as it was a problem of lubrication and thermal insulation of the dies and the holder. Experiments over a two-year period finally resulted in new concepts of the lubrication of hot metal which were applied to the extrusion of steel. The first patents were taken out in 1942, followed by other patents to protect details of the process in its different applications.

The war years were used by the CIE to perfect the new technique and to plan a postwar factory which would be devoted specifically to steel extrusion on a commercial scale. When construction of the actual plant first started, all of the structural steel was requisitioned by the Germans. Several years were then lost in waiting for the opportunity to rebuild a factory at Persan (near Paris) which had been totally destroyed. Work finally began at the end of 1947 and the plant was completed in December, 1948.

Extrusion Advantages

The principal technical advantages of steel extrusion are no different from those commonly attributed to the nonferrous process. The work is done in a few seconds at constant temperature, thus giving uniform mechanical characteristics to the extruded product throughout its length. Forming of the metal is accomplished at extremely high pressure and in

three directions, whereas in other types of hot forming, pressure is generally only in two directions. As a result, the process makes it possible to form alloys which are difficult to roll or to forge. The process can also be used for forming blooms or blanks of steels which are hard to roll on a blooming or cogging mill.

The interior physical structure of extruded bars conforms closely to the exterior surface, thus giving high-rating properties in both transverse and length-wise directions. Extruded products also have remarkable resistance to all bend and flexure tests. An angle section of 1 9/16 by 1 9/16 by 5/32 in., extruded and drawn, can be bent 180 deg. without a crack mark. The same holds true for T-sections. A tube of stainless steel extruded and then flattened out shows no sign of a crack.

The economic advantages of the extrusion process are easily understood. Changing of tools is extremely rapid, and this makes it possible to process without extra overhead small lots of different sections. For example, a nonferrous plant in the Parisian region had in 1938 a daily output of 100 to 200 different sections for different clients on a small 600-ton press. And the cost of making tools is modest. For nonferrous extrusion, it is possible in some cases to use dies made of 9 tungsten, 3% chromium steel, weighing less than 2 lb. and requiring only a few hours of machining.

The cost of installing a press is considerably less than the cost of a rolling mill, and the press can produce an important tonnage, although naturally less than the mill. A brass mill in France, for example, is able to extrude some 10,000 lb. per hr. on a 1000-ton press. In this connection it should be noted that French press builders have introduced some interesting modifications in the technique of extrusion, and this has resulted in an appreciable increase in hourly output.

Waste of metal in hot forming is small. When the operation is well adjusted the only waste is the butt, the thickness of which can be kept down to about ¾ in. In the case of a 28-in. ingot, this represents a scrap percentage of only 0.35%; this includes the bit of bar that remains with the sawed-off butt.

The stock of raw materials consists only of one or two sizes of ingots, resulting in a considerable reduction of stock on hand and insuring that the necessary metal is always available to meet customers' requirements.

Finally, the extrusion process enables the execution of urgent orders in a short time. It is apparent that a production schedule can be changed at any moment without difficulty so that an urgent order can be quickly substituted for a less urgent job. One can readily understand the flexibility of the method when it is compared with a large rolling mill where the "rolling schedule" has to be worked out a long time in advance and, when once set up, can hardly be modified.

Applications

A few examples of the applications of extruded steel products in France should serve to demonstrate the possibilities of the process. Certain manufacturers of conveyor chains use links that have been cut crossways from half-hard steel bars (flats, hot rolled and drawn). They noted a considerable variation in the resistance of steel conveyor belts made by this method and were accordingly obliged to increase the coefficient of safety in the design. The replacement of rolled steel by extruded steel immediately removed these difficulties and has resulted in conveyor chains of constant high mechanical properties.

In another application, certain shapes of pouring channels were formerly produced by planing a block of steel. The product tended to deform when subjected to the heat, thus raising serious difficulties in practical usage. The use of extruded and drawn sections has eliminated this problem—thanks to the longitudinal fibre structure resulting from this process. Today, all pouring channels used in France are made from extruded steel.

In still another field, manufacturers of statistical machines are seeking cost savings by extending their use of shaped sections. In the past these sections have been obtained by a series of cold drawing passes interspersed with annealing. As inspection became more exacting, it was noted that the finished parts varied widely in mechanical properties after heat treatment and rejections were heavy. The use of drawn sections made from extruded bar stock has completely eliminated this difficulty.

Also of interest is the possibility of producing tubes with either exterior or interior cross-sections other than round. One can foresee the use of thin extruded tubes having longitudinal ribs or fins on the exterior, making it possible either to increase the moment of inertia while reducing the weight or to obtain better convection of fluids circulating around the tubes. In the design of heat exchangers, initial use has been made of tubes circular inside and with six ribs on the outside, thus diminishing the volume of liquid circulating on the outside of the tubes. In the design of cranes and other materials handling equipment, where the problem of weight is always important, the use of outside ribbed tubes permits a lighter construction. These same tubes can also be used in truck chassis construction.

Another important possibility is tubing having a circular cross-section inside and a square cross-section outside. At equal weight, these tubes have a moment of inertia higher than that of round tubes. Thus, they can be used for members which must resist buckling, such as scaffolding. The ease of assembling members by welding these tubes on gusset plates will insure rapid extension of their use, it is believed by some construction engineers that, in the future, the square tube will be used in bridge buildings and similar structural work.

It is also possible to obtain tubes with a fixed exterior section but with an interior section variable from one end to the other; thus, the manufacture of tubes with variable moments of inertia can be conceived. The application of such a product can readily be imagined; namely, in cantilever structures (either vertical, such as masts or pylons, or horizontal), the stress at any position being balanced by the particular cross-section at that point.

Generally, the possibilities of designing new products, together with the other technical and economic features outlined here, do not make it absurd to suppose that the hydraulic extrusion press may become a standard tool of the steel plant in the same way as the rolling mill or forging hammer.

Last fall, a hot extrusion process for steel expected to save up to 30% in fabricating costs was announced by a French company. Although patent formalities make it impossible to publish complete details of the process at this time, those features of particular significance to the materials engineer are discussed in this article. As yet no comparable process is in commercial operation in this country, but licensing arrangements for the French process are believed to be underway.

New Indium-Bearing Solders Have Improved Alkali Resistance

Joints made with these new soft solders do not lose strength even after 31-day immersion in strong alkaline solutions.

by S. M. GRYMKO and R. I. JAFFEE, Battelle Memorial Institute

• WHEN CONTAINERS ARE MADE of alkali-resistant materials such as irons, steels and nickel-base alloys, it has usually been desirable to use seamless or all-welded construction. Soft soldered assemblies have been unsatisfactory because the common soft solders have poor resistance to alkaline media. However, the occasion sometimes arises where it would be desirable to use a soft soldered joint in an assembly. As a result of a problem of this sort, soft solders containing indium have been developed which resist the corrosive action of strong alkaline solutions much better than ordinary soft solders.

Soldered joints after corrosion test. On left is a 50 lead-50 tin specimen with arrows pointing to penetration of corrosion products. On right is indium-bearing solder which shows no corrosion.

Background of Development

The particular set of conditions against which protection was desired was in a soldered-in plug in a mild-steel container holding 25% potassium hydroxide at temperatures up to 120 F. A soft solder containing indium was considered a good possibility. G. E. Barton[1] had pointed out that indium, not being amphoteric, like lead and tin, has excellent resistance to the action of alkaline solutions. He found that indium showed a slight weight gain on one week's exposure to alkaline solutions at room temperature; in 5% sodium hydroxide, indium gained weight at the rate of 2.5 mg. per sq. decimeter per day; in 5% sodium carbonate, the weight gain was 0.7 mg. per sq. decimeter per day. Derge and Markus[2] found that additions of 0.1 to 3% indium passivate tin in carbonate solutions from 11.2 to 8.4 pH. Thus, it appeared at the outset that indium itself had good corrosion resistance in alkaline solutions, and, in addition, indium in relatively small amounts in tin improved the alkali resistance of tin.

The resistance of indium and indium alloys to potassium hydroxide was checked by total immersion tests at 120 F, and the results clearly showed that indium and the indium alloy are more resistant to alkaline solutions than lead, tin, or a combination of both (see chart). At the elevated temperature of 120 F, the difference is only in degree of solution, however, and not the difference of weight gain vs. weight loss noted at room temperature. The specimens of indium and 50 indium-50 lead corroded at room temperature were covered with a chalky-white film, assumed to be $In(OH)_3$. At the elevated temperature, indium and 50 indium-50 lead lose weight, and show only a very slight surface film. All of the other specimens remained bright during the corrosion test, indicating that the corrosion products were going into solution.

The corrosion rate of indium in 25% potassium hydroxide at room temperature is 1.5 m.d.d. weight grain after 19 days, and at 120 F is 2.1 m.d.d. weight loss after 22 days. These rates correspond to 0.00030 and 0.00042 in. per year, respectively.

Properties of Indium Solders

Because of the above promising results, the following indium-bearing solders have been formulated and tested:

% Composition		
Indium	*Tin*	*Lead*
10	45	45
10	90	0
25	37.5	37.5
25	75	0
50	25	25
50	50	0
50	0	50

As will be noted binary alloys are included, but most interest was centered about those indium-bearing alloys composed of lead and tin in equal parts. The reason for this is because 50 lead-50 tin is a common soft solder of good strength and good soldering (wetting) characteristics. Pure tin is infrequently used as a solder because of cost reasons and low strength; pure lead is never used

as a solder because of poor wetting properties and low strength. Nevertheless, some binary tin-indium solders and one lead-indium solder were tested to see if there were any special effects when one or the other of the third elements was absent.

Because corrosion in aqueous media is electrochemical in nature, actual soldered joints were subjected to the caustic potash solution. Also, joint strengths and soldering characteristics were evaluated. Tests were performed on soldered joints with and without immersion for one month in 25% potassium hydroxide at 120 F. The test joint was the standard "plug and ring" joint. The thickness of the solder film in the joint was kept at 0.003 in., and in all cases the fillet was wiped away as completely as possible.

The soldered joint tests were intended to find three things: (1) whether there was any loss in strength of the soldered joints as a result of corrosion, (2) whether there was any visible evidence of corrosion penetration in the joints, and (3) to compare the relative strengths of the indium-bearing solders with the indium-free solders.

From the tests it was found that:

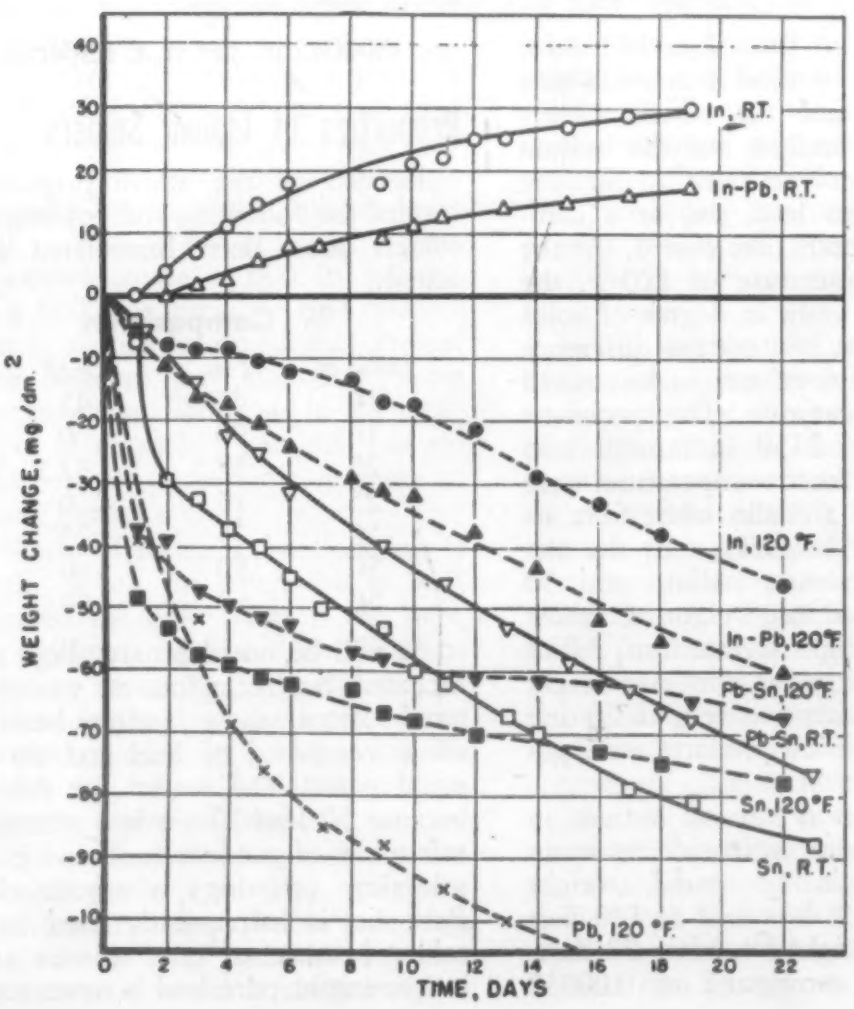
1. The alloys with 25% or more indium are high in resistance to attack by the alkaline solutions. They proved satisfactory in the one-month test, and would be expected to withstand considerably longer exposures.
2. The strongest solder of the ones which resist alkaline attack contains 25 indium, 37.5 lead, and 37.5% tin. Since it also contains the least indium, which is a relatively expensive metal, it is the most desirable solder.
3. The solders containing 25% indium show an appreciable increase in shear strength after the month exposure to 25% potassium hydroxide at 120 F. It is not known whether this is accidental, resulting from the variation in strength of the joints (consistency in joint strengths is difficult to attain), or whether it is a real effect such as an aging-hardening effect. In any case, it is desirable, and proves that the alloys do not lose strength as a result of exposure to alkaline solution.
4. The alloys without indium or with 10% indium are not satisfactory since they are penetrated by the alkaline solution, and lose some strength in a month's exposure. Presumably, corrosion would be progressive, and, after longer exposures, joints made with these solders would be completely penetrated and would be worthless.

The melting range of the 37.5 lead-37.5 tin-25 indium solder is 358 F liquidus and 274 F solidus. This is considerably lower than the 361 F solidus temperature of lead-tin solders. Therefore, the lead-tin-indium alloys have a considerably lower maximum safe temperature of operation. Thus, in applications where high service temperatures are encountered, the 50 lead-50 indium solder, which has a solidus temperature of 360 F (the same as lead-tin solders), should be used. For still higher operating temperatures, indium content can be cut back to 25% indium with 75% lead. This alloy has a solidus temperature of 446 F. However, it should be remembered that reducing indium content much below 25% lowers alkali resistance.

In general, the methods of applying the lead-tin-indium solders are identical to those used for regular sweating type lead-tin alloys. Wetting tests of 37.5 lead-37.5 tin-25 indium and 50 lead-50 tin solders at 545 F, using both acid and rosin fluxes, indicate that the indium-bearing solder is slightly superior.

As to cost, the indium-bearing solders are much higher in cost than ordinary lead-tin solders. At the present price of indium, $2.25 per troy ounce, the cost of a solder containing 25% indium is about $8.50 per avoirdupois pound as compared to $0.46 per pound for 50 lead-50 tin solder. Therefore, in considering the use of indium-bearing solders for parts in contact with alkaline solutions, this high cost must be weighed against the advantages of increased service life.

Total immersion corrosion tests of various soft solders in 25% potassium hydroxide solution.



The permission of Consolidated Mining & Smelting Co., Trail, B.C. Canada, to publish this work is acknowledged with thanks.

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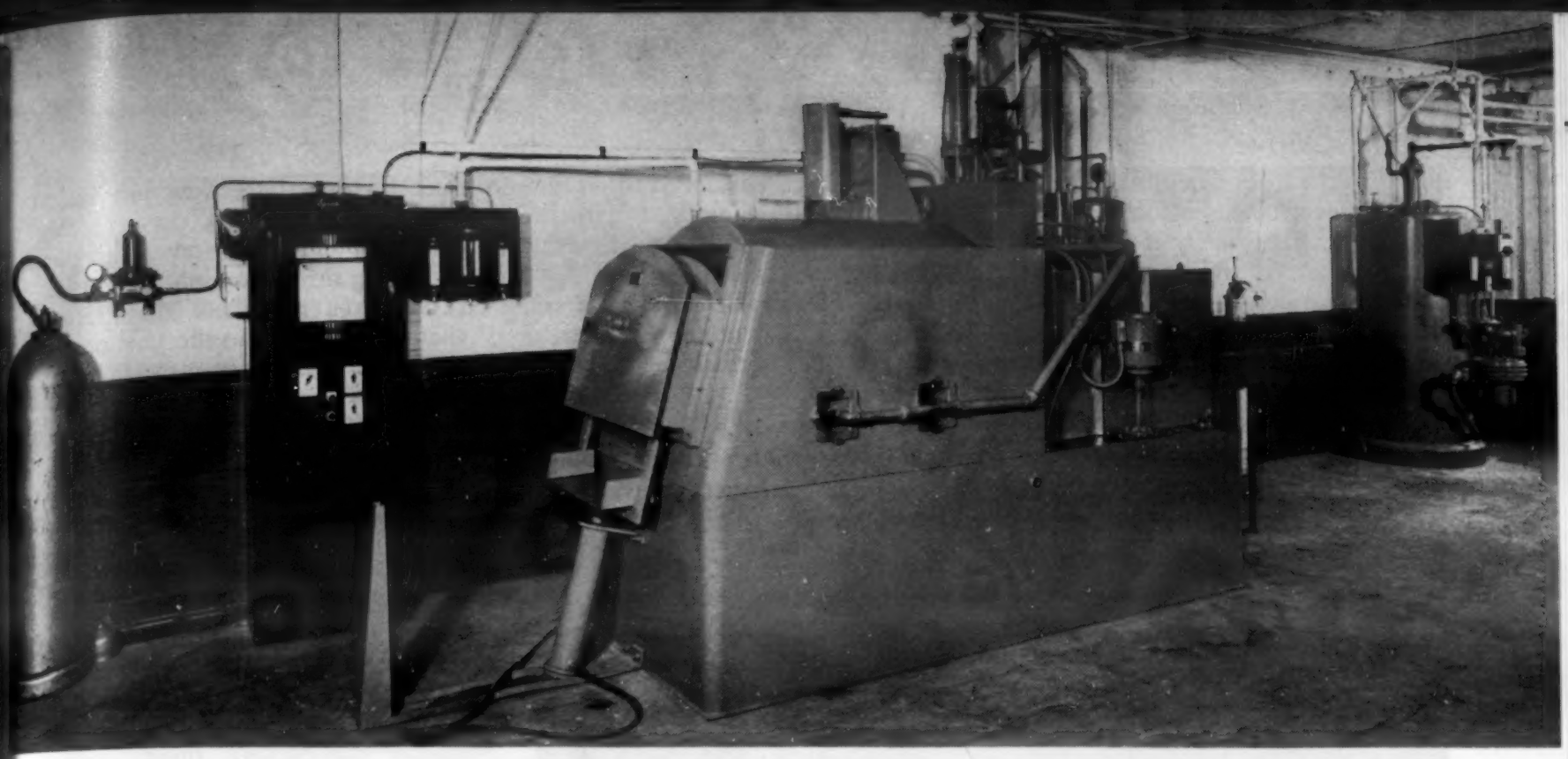
[2] *Derge, G. and Markus, R., "Studies on the Corrosion of Tin, Effects of Cation in Carbonate Solutions, and the Effects of Alloying Elements,"* Transactions of the American Institute of Mining & Metallurgical Engineers, *143, pp. 198-208, (1941).*



View of carbonitriding equipment consisting of furnace, cooling chamber and quench tank all in one unit.

Bright Carbonitriding of Steel Accomplished in Automatic Furnace

by H. N. IPSEN, President, Ipsen Industries, Inc.

Combination of protective atmosphere and automatic control of quenching medium insures bright, clean surfaces, uniform case depth, and eliminated distortion on wide range of parts.

• CASE HARDENING has long been used to obtain efficient and economical use of steels. The most common methods of providing a case on steel are: (1) pack carburizing; (2) liquid carburizing (salts and cyanides); and (3) gaseous methods. The first two methods are well known through long use and frequent description, but some mystery surrounds gaseous methods of case hardening.

Process Description

There are two principal treatments for providing a case by means of gases. One method involves the heating of steels in the presence of rich hydrocarbon gases such as butane, propane, natural gas, etc. Anhydrous ammonia is often added to these gases to add nitrides to the forming case. The gases which provide the case also act as protective atmospheres. The second method requires a carrier gas to protect the steel and then uses only a small percentage of the hydrocarbon gases to form the case desired. In the second method, also, anhydrous ammonia is often used to add nitrides to the case. The addition of ammonia to either of the gaseous methods results in a process known as carbonitriding. The second method, using a protective atmosphere, results in faster casing, more uniform case depths, and controllable case composition.

Although bright carbonitriding is not entirely new, it is relatively new in respect to the treatment of medium and large parts. Earlier applications of such treatments were usually restricted to small parts. The first attempts at carbonitriding larger parts produced work that was clean, but not bright. The work was done in an automatic furnace suitable for use with controlled atmospheres at temperatures up to 1750 F. The equipment consisted of a furnace, cooling chamber, quench tank, chain hearth, circulating fan, pneumatically operated front and rear doors. The water jacketed cooling-quenching chamber contained an oil bath for quenching. The equipment was designed for completely automatic operation.

Brightness was achieved and excessive distortion eliminated by a complete redesign of the quenching set-up, after it was found that most of the difficulties resulted from air entrapment in the oil, and excessive pressure of the oil against pieces be-

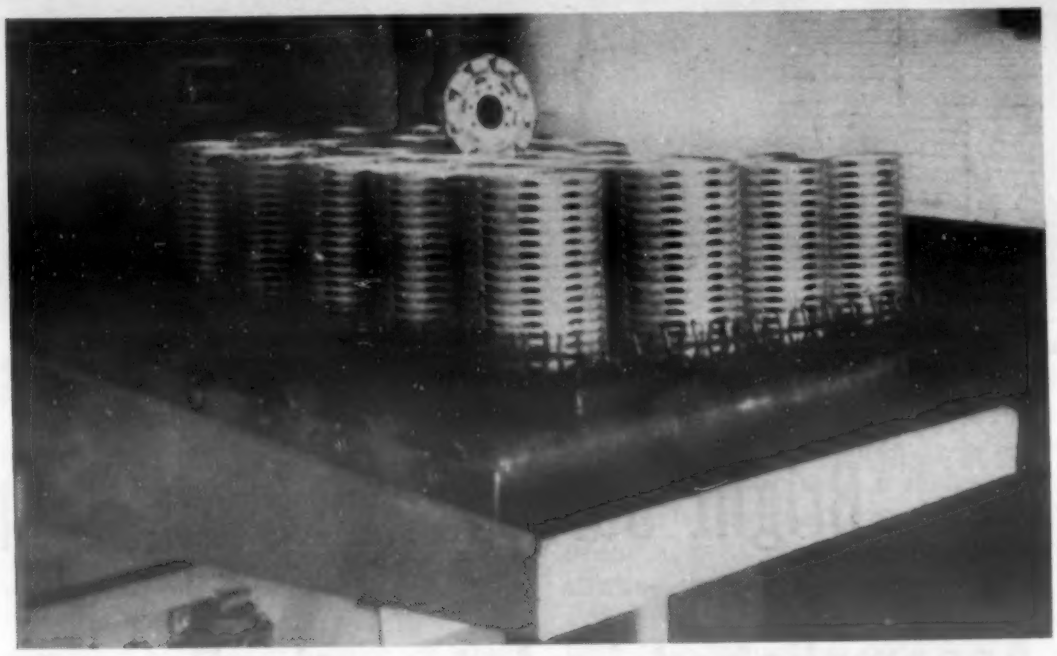
ing quenched. In the final design, raw air never comes in contact with the oil, because the quenching medium is protected by the same atmosphere that protects the work. In addition, the oil now flows over the work after the loaded trays are moved into the quench tank. Rate of oil flow is automatically controlled, with the most rapid flow cycle for the first few seconds of the quench period.

As the oil quench is designed and controlled, maximum hardness is achieved. The return to a slow quenching medium flow just below the nose of the TTT curve reduces distortion and eliminates cracking by providing slower cooling at the lower temperatures where the greatest change of volume in the steel occurs.

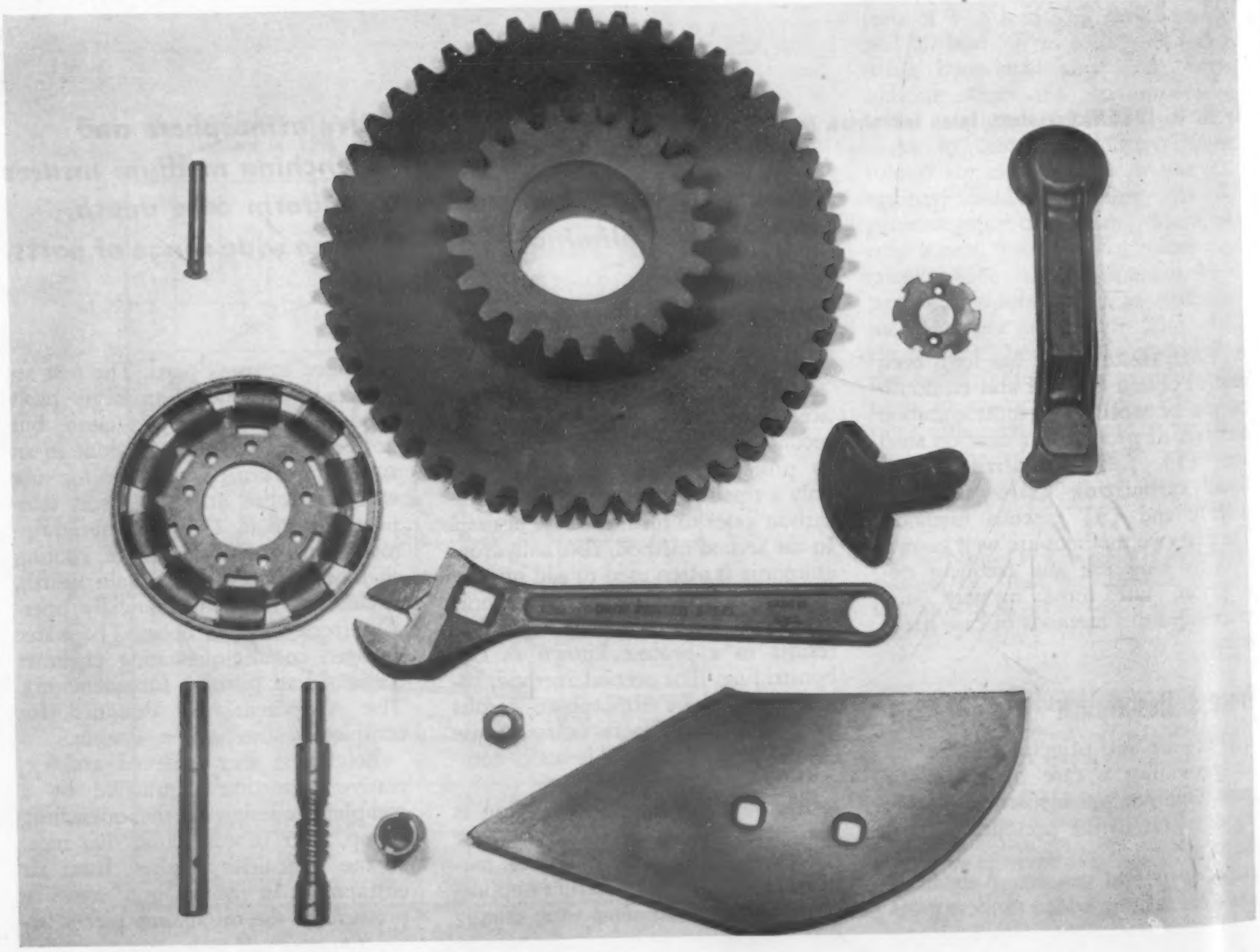
The gas generated for use in bright carbonitriding has an approximate analysis of 40 hydrogen, 40 nitrogen, 20 carbon monoxide, 1% methane and free of carbon dioxide and oxygen. The dew point is approximately 50 F.

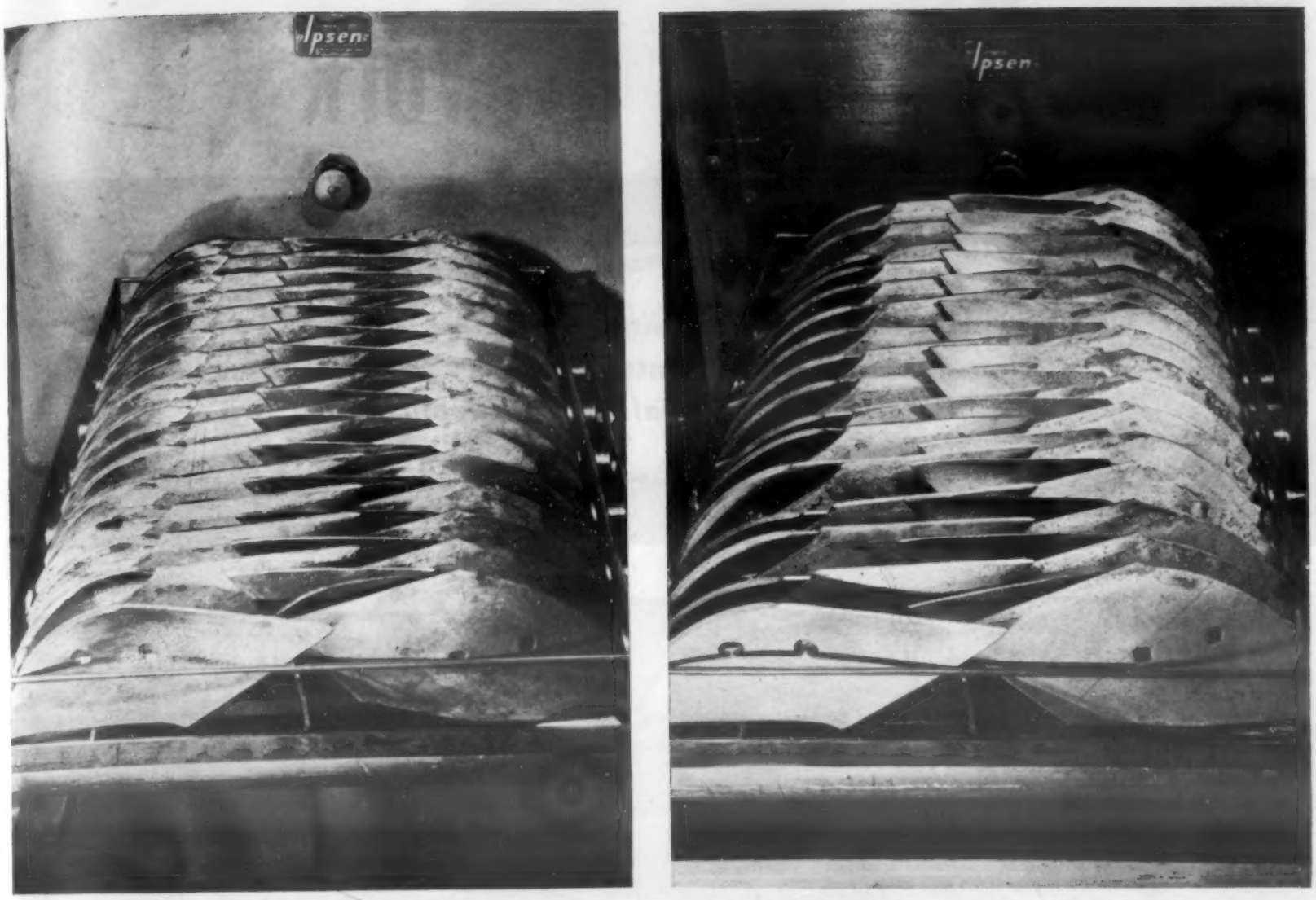
Parts to be carbonitrided in this equipment are loaded in trays which carry them throughout the heating and quenching cycle. After being placed in the furnace they are then moved in accordance with the times set on the furnace timer, quench timer and oil flow timer, upon the pushing of the furnace's start button. After heating for the proper time, the parts are moved into the cooling chamber, are quenched and, when cooling is completed, a signal light indicates to the operator that the work can be removed from the furnace.

Clutch plates shown here, weighing about ½ lb. each, were case hardened by bright carbonitriding process at a considerable saving.



A wide range of parts and sizes can be satisfactorily treated by carbonitriding.





Load of jointer points shown at left before heat treating at 1625 F for 45 min. and quenching in oil. Right shows bright appearance of parts after heat treatment.

Results Achieved

Generally, low carbon steels such as SAE 1020, B-1112 or C-1119 are the types used in parts to be carbonitrided. Pieces made from these steels can be case hardened in the type of equipment described and be removed from the furnace with a lustrous surface equal to the original finish. Even those parts that have a hot rolled finish or which have rusted will be removed from the quench with a satin finish. In the latter case, the carbonitriding atmosphere reduces the iron oxide. Medium alloy steels will have a light gray finish after carbonitriding, and the high alloy steels such as stainless will show dark gray.

The elimination of water or brine as a quenching medium and the production of a case depth more rapidly are two of the outstanding features of bright carbonitriding. As an example, there is a forged wrench shown in an accompanying illustration. The part was heated to 1600 F, carbonitrided for 1 hr. and then quenched in oil. The treatment resulted in a case depth of from 0.009 to 0.010 in. with a file hard surface and a core hardness of 45 to 46 Rockwell C. Formerly the part was carburized and water quenched.

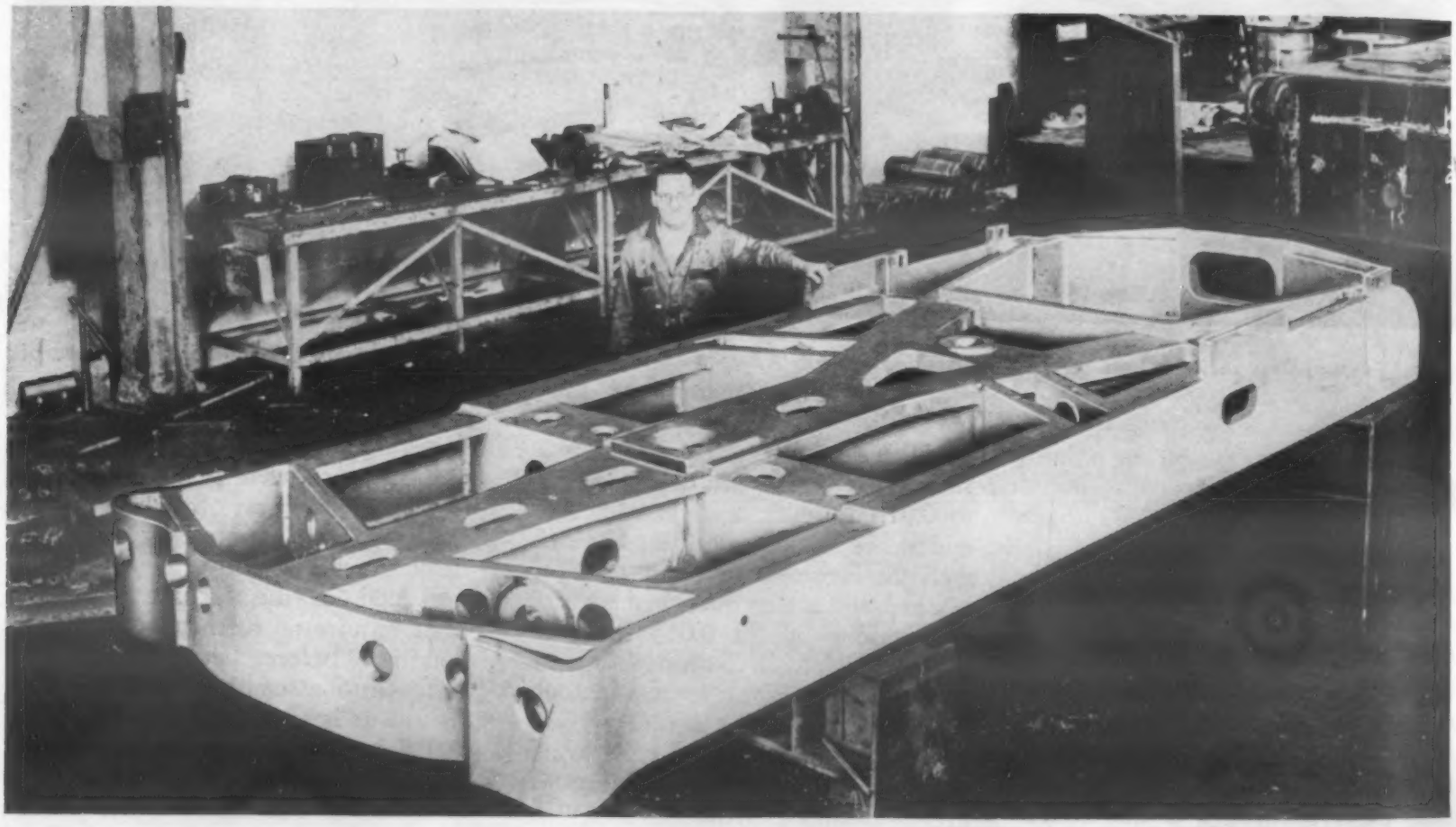
A case depth of 0.013 in. is attained on small bushings by the bright carbonitriding process in about 1 hr., 20 min. The bushings were formerly gas carburized and water quenched. Bright carbonitriding has greatly reduced grinding time formerly required. The bushings are taken from the automatic screw machine boxes and loaded onto the heat treating rack. The parts are carbonitrided for 1 hr., 15 min. at 1600 F and quenched in oil for 3 min. with a high oil flow of 45 sec. The atmosphere is composed of 250 parts of generated gas, plus 25 parts of natural gas and 25 parts of ammonia.

Clutch plates made of 1020 steel and weighing about ½ lb. each are case hardened at a considerable saving by means of the bright carbonitriding process. Formerly, the parts were individually wired, liquid cyanided, water quenched and de-wired. This step was followed by a hot water rinse and dry, and oil dip and then the parts were packed in assembly boxes. The cost of treatment was over 2¢ each. The plates are now carbonitrided at the rate of 250 lb. per load in the furnace. Finished parts require no further treatment or handling before being loaded directly into assembly boxes. Cost of treatment is approximately ¼¢ each.

Bright work is not confined to carbonitriding. An example is the straight heat treating of jointer points of farm implements. In previous processing, the points were brine quenched from a rotary furnace and polished on the front side both before and after heat treatment. Bright heat treating eliminated the need for a final polish. Polishing is now required only after forging. The jointer points are made of 3-ply material. The outer layers are SAE 1090 with a low carbon, fine grain center. After bright heat treating at 1625 F for 45 min. and an oil quench, the outside hardness is between 555 and 688 Brinell and the core is 20 to 30% intermediate transformation in a ferritic matrix and consistent throughout. Approximately 300 lb. are treated per hour.

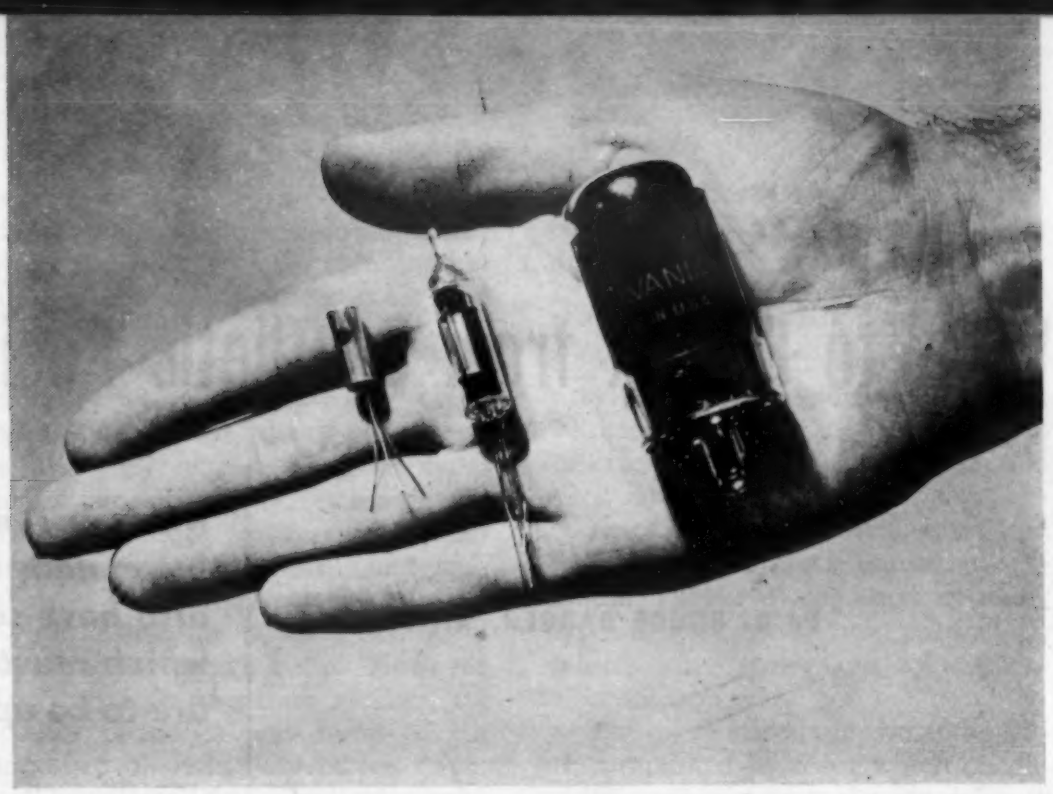
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



WELDED STEEL CRANE BASE *When the casting which served as the rotating base of a locomotive crane broke near the pivot point and original patterns were unavailable for a recasting operation, the drawings of the unit were sent to R. C. Mahon Co., where the base was redesigned for steel-weld fabrication. The redesigned base was produced in much less time than would have been required by casting, and the base was completely machined within the plant and ready for assembly.*

POLYVINYL CHLORIDE FORMS *This expanded unicellular polyvinyl chloride material, known as Plasti-Cell and produced by the Sponge Rubber Products Co., is light weight and has extremely low water absorption. The compression range runs from 1½ psi. to 150 psi. Insulation value is illustrated by a K factor of 0.20 or less, depending upon density. The material is non-toxic, odorless, imparts no taste, and is claimed to have excellent electrical properties. Suggested applications include net floats, buoys, marine fenders, kitchen equipment, and children's toys.*

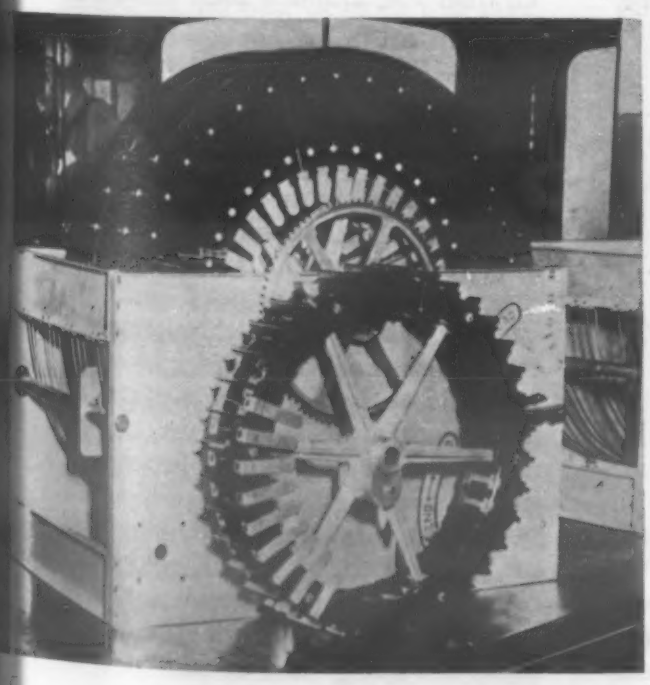


GERMANIUM CRYSTAL MIXER

Possibilities of miniaturization in radio circuits are increased with development by Sylvania Electric Products, Inc. of a laboratory model of a four-terminal germanium crystal mixer. This mixer, smallest yet developed, is shown for comparison purposes with conventional mixer tubes of the standard and subminiature types.

RUBBER SPRINGS

Springs, operating on a torsional shear principle, and consisting of a thick layer of specially compounded rubber sandwiched between two metal plates, have been developed by the U. S. Rubber Co. for use on tractor seats. The rubber is fastened to the metal end-plates by a brass plating process. As the tractor rides over rough ground, the rubber twists and absorbs the initial shock and sharp rebound normally present in steel-spring seats. The springs can be adjusted for varying weights of drivers, and are mounted in pairs on seats manufactured by the Bostrom Manufacturing Co.



PHENOLIC VENDING MACHINE PARTS

Making the vital parts of this new ice cream vending machine of plastics instead of metal saved the manufacturer about 35% of the retail price. The machine serves ice cream pops at the drop of a coin, makes change when necessary, and automatically reloads four dispenser units from a large, built-in, storage space. The dispenser unit rings are molded in two circular sections from Bakelite general purpose phenolic material and fastened together on a spider. Formerly, these rings were made from die-cast metal. Eight molded plastic shaft bushings replace soft metal bushings originally used. Laminated phenolics are also used for drum facings and spacer bars on the rotary units because of their strength, lack of weight, ease of assembly, dimensional stability, and corrosion resistance. The shift to plastics in this machine, manufactured jointly by Eastern Engineering Sales, Inc. and the Dexdale Hosiery Mills, eliminated several machining and finishing operations, and enabled production of a unit 30 lb. lighter than the all-metal model it replaced.

What to Expect from Synthetic Resin Finishes

by N. BRUCE BAGGER, Associate Editor

Modern synthetic resin-base finishes have many excellent qualities, but they also have some definite limitations which must be considered if they are to be applied intelligently.

● MANY NEW COATING and finishing formulations have appeared on the market in recent years. Some of these have been heralded by glowing phrases, and over-zealous claims. In fact, many, like the old-time medicine show snake oil, are "guaranteed" to perform miracles irrespective of the application to which they are applied. The word "plastic" has often been loosely used in describing these different finishes. Most reputable manufacturers abhor this practice, since it infers that the product is unlike a conventional paint and instead imparts a plastic outer layer having the chemical resistance associated with molded or laminated plastic materials. True plastics are converted under heat or pressure to a substance that is insoluble, durable and solid. In the so-called plastic coatings, reaction must be arrested at one stage or another to keep the product soluble. For this reason, there is obviously little justification in talking about a "plastic" paint. For the most part, the finishes that are so-called are simply synonymous with synthetic resin coatings and differ little from the varnish and lacquer qualities that have been used in the past.

Synthetic resins are resinous materials which are built up or synthesized by the union of simpler compounds. The compounds may be phenol, formaldehyde, glycerine, phthalic anhydride, rosin, oils, and many other types. The variety of raw materials and precise control in manufacture make it possible to manufacture synthetic resins which are superior to the natural resins in such properties as durability, hardness and toughness.

Large numbers of synthetic resins have been synthesized and are in use. The best grade for use in vehicles is the glyceryl phthalate type modified with oil and commonly called the "alkyd resin vehicles." In this type, the oil enters into the reaction of the glycerine and phthalic anhydride and a complex molecular structure is set up. The trend in vehicle formulation is definitely in this direction of chemically combining the oil with the other ingredients to obtain superior products.

Some synthetic resins are so flexible and tough that they do not require the presence of oil in their composition. These types, of which the vinyl resins are an example, do not dry by oxidation due to the absence of oil, and require heat to complete their chemical reactions to a hard, tough, resistant, durable film. However, cost is a limiting factor in their use at the present time.

The most important synthetic resins in current use are the 100% phenolics, the modified phenolic types, and the maleic types, all of which are oil soluble; and the oil modified glyceryl phthalate or alkyd types.

Phenolics

The properties of the 100% phenol-formaldehyde resins are dependent upon the types and purity of the reactants. The best types can be combined with all the drying oils to produce vehicles of excellent durability, good hard drying, and remarkable resistance to acids and alkalies. For instance, a varnish made up of 100 lb. of a 100% phenolic resin, together with 25 gal. of "molecular selected" linseed oil will withstand the action of a 5% solution of caustic soda for 7 hr. without failure. While it is not often necessary to have this degree of alkali resistance, it does illustrate what can be accomplished with a good resin and a good oil. Most films would fail within a few minutes in such a test.

The 100% phenolic-oil vehicles are used wherever the properties noted are necessary, such as in enamels and varnishes for boats and for underwater exposure, paints to withstand corrosive fumes, etc.

The 100% phenolic-oil vehicles have the disadvantage of discoloring in sunlight, and cannot be used in white enamels or light tints where color retention is necessary.

The relatively high performance of the 100% phenolics makes possible their modification by the addition of other raw materials, such as rosin or ester gum. These diluents are added during the reaction of the phenolic resin constituents to get the maximum effect on the phenolic resin. The properties of the resin produced fall between the properties of the phenolic resin and those of the diluent, although the effect of the phenolic constituents is usually greater than the amount used would indicate.

The modified phenolics on the market usually contain up to 25% phenolic resin. They are a marked improvement over ester gum. They can be used with the drying oils, such as tung oil, "molecular selected" oil, and dehydrated castor oil, to produce good drying vehicles, with satisfactory viscosity, good water resistance, and fair durability. In alkali and acid resistance they are an improvement over ester gum but do not approach the 100% phenolics in these properties. Color tends to be poor, and they are usually not used in whites where initial color and color retention are important. Vehicles made with the modified phenolics are being used in many places.

"Molecular selected" oil gives very good results with these resins.

Maleic Resins

In the reaction of rosin and glycerine to form ester gum, if a third ingredient, maleic anhydride, is added, a very complex resinous material called a "maleic resin" is formed. If the amount of maleic anhydride is not too great, the resin will dissolve in oil to form useful vehicles. This type of resin is much different than ester gum in that it forms good drying, high viscosity vehicles with all the drying oils. These vehicles have the good color and color retention second best to the alkyd type and have been widely used in white and colored enamels. The vehicles compare in durability to those made with the modified phenolics, but color and color retention are better.

Alkyd Resins

The basic reaction to form an alkyd is the chemical reaction of phthalic anhydride and glycerine. If this reaction is allowed to go to completion, a hard, tough, light colored resinous product, insoluble in oils, is formed. It is, however, possible, by proper procedures, to introduce drying oils into this reaction so that they will combine chemically with the reactants and form what is commonly known as the oil modified alkyd resins.

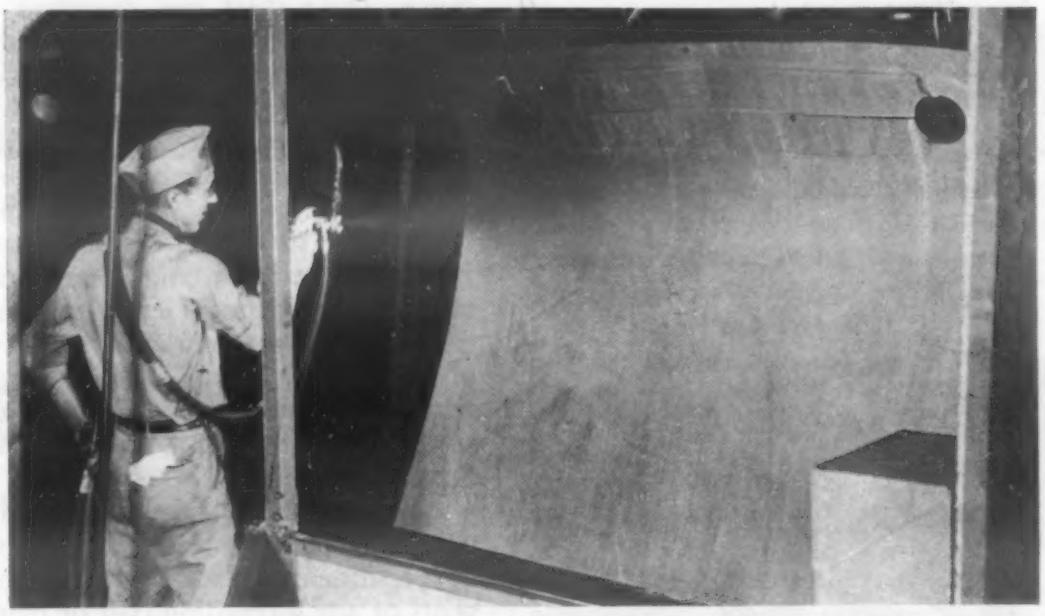
The method of making this vehicle is basically different from the procedure of taking a resin such as the 100% phenolics or any of the other oil soluble resins and dissolving them in the oil. It is true that with appropriate heat treatment and due to the chemical composition of the resin, reaction of varying degrees will take place between the resin and the oil, but this reaction is not nearly as complete as in the oil-modified alkyd types. This fact is shown by the better durability, flexibility, and toughness of the latter type.

All the drying oils can be used in alkyd resin vehicles. The inherent toughness of the glycerine-phthalic anhydride combination and the fact that the oil is in chemical combination with it necessitates the use of less oil than is necessary with other resins to get equal flexibility. Therefore, the large differences that show up in drying between various oils with other resins are not so apparent in this composition. Tung oil is rarely used because drying equal to it, for all practical purposes, can be obtained with linseed oil. Soya bean oil produces vehicles that dry much better than in any other resin combination and is used where pale color and color retention are desired.

The oil modified alkyd resin vehicles dry very well to form tough, hard films which retain their flexibility. They exceed all other types in exterior durability, including the 100% phenolic resin types. They form pale films which discolor only slightly, depending upon the oil used. Water resistance is good and so is resistance to mild alkalies. However, for resistance to strong alkalies, the 100% phenolics and some of the modified phenolics are better.

The oil modified alkyd resin vehicles are an extremely useful class of vehicles. One of their first important uses in finishes was to replace lacquer type finishes on automobiles. The drying here was speeded up by heat at temperatures around 250 to 300 F. They were more durable and considerably more economical than the previous lacquer type finishes. These vehicles are being used in all types of exterior finishes such as porch and deck enamels, house trim paints, cement paints, implement finishes, and automobile and truck refinishing enamels. They are also used in many types of interior enamels, particularly whites where color and color retention are important.

The oil modified alkyds can be further modified by rosin which chemically combines with the glycerine in the reaction and by the addition of phenol-formaldehyde constituents.



Synthetic resin coatings are widely used in the automobile and truck industry. Here a large truck panel is being sprayed.

Many of the synthetic resin-base finishes used on metal products are dried by baking at temperatures up to around 300 F. Here shown are finished parts leaving the baking oven. (Courtesy Despatch Oven Co.)

These modifications either lower costs or promote quicker through drying of the film. They reduce durability and color holding properties and are in use much less than the straight oil-modified types.

The oil-modified alkyd vehicles are becoming increasingly important because of their superior properties, and have been replacing and will undoubtedly continue to replace more and more the modified phenolic and maleic type vehicles.

In addition to coatings of the foregoing synthetic resins, others, utilizing rubber and asphalt, are commonly used for heavy duty applications where resistance to moisture, acid, excessive wear, etc. is of considerably more importance than appearance and general decorative value.

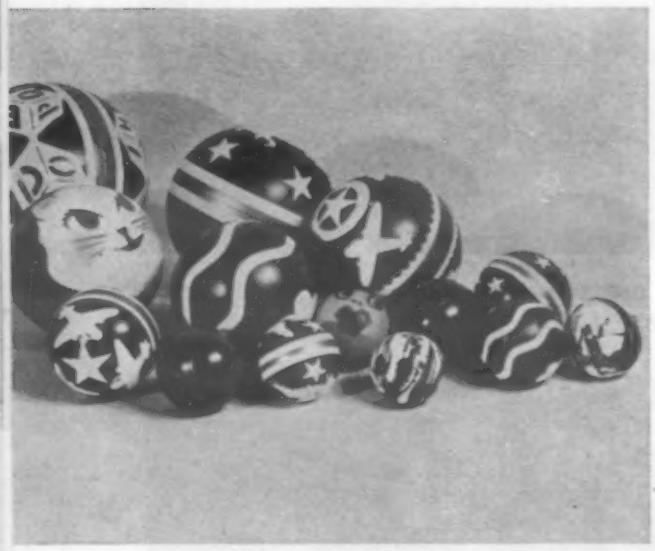
Asphaltums

The asphaltums are black, opaque, resinous substances of widely varying degrees of hardness, ranging from soft pitches to hard, brittle materials. They occur in natural deposits or as by-products from petroleum refining. Asphaltums of any desired degree of hardness can be obtained by blending soft and hard types. The soft types of blends of hard and soft types can be used merely by solution in a thinner. To improve toughness and resistance to wear, limited quantities of oil can be used with them. They retard the drying of oils so that it is necessary to keep the oil content low if reasonable drying is to be obtained. The hard, brittle types retard drying less than the softer types.

Asphaltums are rarely pigmented because of their dark color but are used as black paints which have sufficient hiding without the addition of black pigments. Asphaltums have very excellent water and acid resistance. Their chief use, therefore, is as a waterproofing agent to damp-proof concrete and masonry, acid-proofing concrete and metal surfaces, etc. The soft asphaltums have satisfactory exterior durability as evidenced by their use in roofing materials but they lack the hardness, freedom from tack and wear resistance of a paint satisfactory for general use. For that reason a majority of the asphaltic paints are formulated with hard asphaltums and relatively small quantities of oil so they have limited durability.

As a general black enamel, their use is limited to surfaces that are to be permanently black since the solvents of any succeeding coat of paint will soften the asphaltum and discolor any color except black.

Rubber balls coated with a pale, amber-colored thermoplastic elastomer to provide a tough and extensible film. (Courtesy Eagle Rubber Co. and Goodyear Tire & Rubber Co.)



Rubber Resins

Rubber in its natural form is only slightly soluble in thinners, but by treatment with chlorine, hydrochloric acid, or other materials, its solubility is increased so that usable solutions of around 20% rubber content can be made. The initial properties of rubber are greatly changed by the processing, becoming hard and brittle. The addition of small quantities of some of the drying oils plasticize it and reduce brittleness.

Vehicles made in this manner are very resistant to acids and alkalies and find their chief use in finishes exposed to these chemicals. They are widely used as sealers and finishes for concrete floors where the alkali present has no effect on the vehicle. They dry rapidly through evaporation of the solvent since their oil content is low. They are occasionally added to other drying materials to improve drying.

These derivatives have been made from natural rubber, although some experimental work indicates that similar products can be made from synthetic rubber.

Steel barge painted with synthetic resins in a solvent of aromatic hydrocarbon. Special pigments have been added for coloring purposes. Coating resists corrosive attack of sea water exceptionally well. (Courtesy Corrosite Corp. and Penn Stevedoring Corp.)

Silicones

Among the greatest advances made in the coatings field has been the development of the silicone resins. These resins give to protective coatings a combination of properties which few other resins possess. They have exceptional resistance to heat, cold and moisture, and are unusually resistant to most chemical fumes and to attack by dilute and concentrated acids, alkalies, salts and oils. These properties are inherent in the chemical structure of the silicones. Built on a stable molecular skeleton of alternate silicon and oxygen atoms, they acquire flexibility, solubility, and ease of handling through the presence of one or more organic radicals attached to each of the silicon atoms.

The properties of the silicone resins developed for use in formulating protective coatings lie between those of the better organic finishes and the vitrified enamels. Silicone-based finishes are already being produced which have much greater heat stability, weather resistance, and durability than the best organic coatings.

From these many different types of resin finishes that are available the materials engineer can select the particular coating formulation best suited for a given application. No single type is designated as a cure-all coating for every finishing requirement, but each has certain specific advantages and these must be considered before an intelligent selection can be made.

Materials & Methods Manual

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

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The Thermoplastics

by William Schack

Thermoplastics make up one of the two main classes of that diverse group of industrial materials known as plastics. They differ essentially from the other group—thermosetting plastics—in their ability to be reshaped upon being reheated. Thermoplastics are a versatile group of materials, and highly economical processes have been developed to convert them into finished and semi-finished products. This manual covers the many kinds of thermoplastics available, giving detailed descriptions of their performance characteristics and properties, and the methods of fabricating them.

Contents

Introduction

Of the two broad classes of plastic materials—thermosetting and thermoplastic—the latter provided 15% of the molding materials consumed in 1940, 50% in 1948. This increased use is due not only to the versatile nature of the materials themselves, but also to the highly economical processes developed to convert them into finished and semi-finished products. The thermosetting plastics having been the subject of the MATERIALS & METHODS Manual No. 49 (May 1949), this paper is confined to a discussion of the thermoplastics.

Essentially, this group of materials differs from the thermosets in that they can be reshaped on being reheated, while the thermosetting plastics cannot be made to undergo further change of shape once they have been cured under heat and pressure. The molecular structure which is responsible for this characteristic of the thermoplastics also makes them soften in a temperature range much below that of the thermosets. While their heat distortion temperature varies from the 280 F of urea-formaldehyde to the 400 F of melamine-formaldehyde, at 264 psi. fiber stress, the range of the thermoplastics is from the 107 F of polyethylene to the 245 F of heat resistant cellulose acetate, at only 64 psi. fiber stress (values at the higher load are not available in most cases).

While the low heat distortion point definitely restricts the usefulness of this group where dimensional stability at an elevated temperature is required in a product, the limitation must not be interpreted too narrowly. In no sense does degradation of the material take place at the softening point—though the values of certain properties decline with increased temperature. Actually, the thermoplastics cannot even be molded except at substantially higher temperatures. The type of acetate mentioned, for example, is molded between 420 and 490 F. Some nylons are molded at temperatures up to 530 F. Heat distortion temperature is not an index of the inherent strength or weakness of a material, for nylon and polyethylene are virtually unbreakable. Nor is it even synonymous with the service temperature, since many applications which are not subject to load can make use of thermoplastics at higher temperatures. Thus, despite a heat distortion point of 107 F, polyethylene not subjected to stress has good form stability up to 219 F, which is only 4 deg. below the temperature at which it becomes plastic enough to mold. It therefore easily satisfies the service temperature of wire and cable applications, which is about 185 F, and it can even withstand sterilization in boiling water. So can molded saran and nylon parts. Heat resistant cellulose acetate has been approved by the Underwriters' Laboratories as a housing for certain mixers and other household appliances.

There are also a great many applications in which temperature requirements are negligible. In these, light weight, low water absorption, color range, chemical resistance, mechanical or dielectric properties, or a combination of any of them, might be the important specifications; and these may well be found in one of the thermoplastics.

The principal commercial types of thermoplastics are as follows (common trade names are given in parentheses as a convenient and sometimes more familiar reference):

- Acrylic, or methacrylates (Lucite, Plexiglas)
- Cellulose acetate (Ampacet, Fibestos, Hercules Cellulose Acetate, Koppers Cellulose Acetate, Lumarith, Nixon C/A, Plastacele, Tenite I)
- Cellulose acetate butyrate (Tenite II)
- Cellulose nitrate, or pyroxylin (Celluloid, Nitron, Nixon C/N, Pyralin)
- Cellulose propionate (Forticel)
- Ethyl cellulose (Ethocel, Hercules Ethyl Cellulose, Koppers Ethyl Cellulose, Nixon E/C)
- Nylon
- Polyethylene, or polythene
- Polystyrene (Bakelite Polystyrene, Catalin Polystyrene, Koppers Polystyrene, Lustrex, Styron)
- Polytetrafluoroethylene (Teflon)
- Polytrifluorochloroethylene (Kel-F)
- Polyvinyl alcohol (Compar)
- Polyvinyl butyral (Butacite, Saflex, Vinylite)
- Polyvinyl chloride and copolymers (Geon, Marvinol, Pliovic, Ultron, Vinylite)
- Polyvinyl formal (Formvar)
- Polyvinylidene chloride, or saran (Lumite, Velon)

Of these materials, two are also available as expanded plastics—acetate (Strux) and polystyrene (Styrofoam).

It should be understood that, in addition to the diversity of thermoplastic types, each one of these is capable of wide variations in formulation. Since they are high polymers, that is, made up of extremely large molecules formed by the agglomeration of units of one or more small molecules (monomers), their composition can be varied by controlling the conditions of polymerization. In the case of the cellulosics, another chemical differentiation is achieved by controlling the degree of esterification; the acetyl content can range from 36 to 42%. In the case of copolymers, such as vinyl chloride-vinyl acetate copolymer, the proportions of the two basic monomers can be varied. A second great source of variations in formulation is the plasticizer added to the base resin. A plasticizer is a high boiling organic liquid or low melting solid which endows the resin with improved flow characteristics and imparts greater toughness and flexibility to the finished product. Some plasticizers give it flame resistance, better weatherability, and other desired properties. By improving adhesion, flexibility and outdoor durability, these softening agents have made possible the development of lacquers for automobile and household uses. While half a dozen of the materials listed above do not require any plasticizer, the vinyls and cellulosics would be practically unworkable without them, and their properties are markedly affected by the type and amount of plasticizer used. Other additives—pigments and dyes, stabilizers and fillers (confined chiefly to the vinyls)—likewise affect the properties of the base resin. With all these possible variables, it is hardly surprising that elastomeric polyvinyl chloride and its copolymers are available in hundreds of formulations, aside from their rigid forms.

A complete specification for a molding compound, therefore, must state the basic resin type, the manner in which it is to be processed (injection, extrusion), the flow desired (which is governed by the plasticizer, ranging from H6—very hard—to S3—very soft), the color, the form of the material (granules, pellets), and size.

Styrene copolymer, of which this molded tumbler is made, has greater impact strength than standard polystyrene grades. (Courtesy Rohm & Haas Co.)

Types of Thermoplastics

Since this article is not addressed to chemists, only a few elementary facts need be mentioned which affect the properties and relationships of the various thermoplastics. It is worth noting that the cellulosics are all derived, on one "side," from cellulose. Four of them are esters, that is, salts of acids—acetic, acetic and butyric (mixed ester), nitric, and propionic acids. This makes them more akin to each other than to ethyl cellulose, which is an ether, or organic oxide, of cellulose.

The vinyl resins constitute an even more varied group. Commonly the term is applied to polyvinyl chloride and its copolymers (chiefly with vinyl acetate and vinylidene chloride), polyvinyl formal and polyvinyl butyral. But the acrylics and polystyrene also contain the chemical group characteristic of the vinyls (polystyrene being a vinyl benzene).

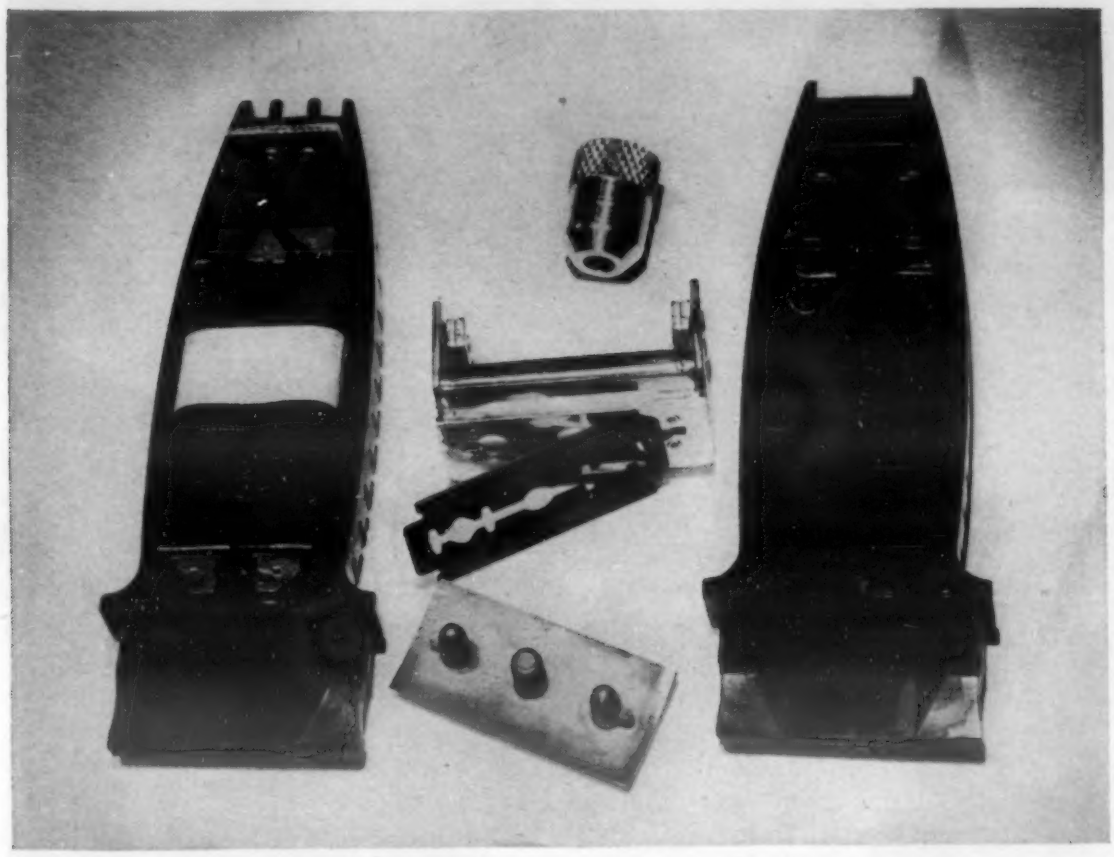
In common with the vinyls, polyethylene, polytetrafluoroethylene and trifluorochloroethylene are derived from ethylene. The fact is reflected in their high chemical resistance and their waxy character. But chemical kinships do not tell the differences between the materials. For this, a detailed consideration of each type is necessary.

Acrylics (Methyl Methacrylate)

This term covers a series of materials ranging from soft, sticky, semi-fluid resins to hard, tough, solid ones. The former are used for adhesives or as modifiers for other resins employed in hot-melt adhesives of potting compounds. They are also used as binders for pigments, for coating paper and cloth, for finishing leather, and for stiffening collars. The most important form of acrylic is polymethyl methacrylate, which is familiar as brilliantly clear sheet and rod as well as molded parts.

This material is characterized by resistance to outdoor weathering, good dimensional stability and low water absorption. It is odorless, tasteless and non-toxic, and the most rigid formulations will withstand boiling water without deformation under "no-load" conditions. Although the material does not shatter as easily as glass under a blow, it scratches more easily. The visibility of scratches, however, can be greatly reduced by wax polishing compounds.

Typical applications taking advantage of toughness, transparency and weatherability are aircraft canopies,



A razor housing injection molded with ethyl cellulose in two identical halves which are bonded together to form a water-tight enclosure. (Courtesy Hercules Powder Co.)

automobile tail lights and trim, and outdoor signs. The chemical resistance of the material is demonstrated in dentures and teeth, contact lenses and individually formed hearing aid parts. Its transparency makes it suitable for optical lenses and prisms, watch crystals, demonstration models and decorative items.

Light introduced at one end of an acrylic rod or sheet is internally reflected from the polished surfaces and emerges essentially undiminished at the other end. This property, which it shares with polystyrene, is used to create edge-lighting effects in signs and to bend light in medical inspection instruments.

Cellulosics

Cellulose acetate is notable for its toughness, impact strength and ease of molding and fabrication. Its chief limitations are its cold flow under stress and its susceptibility to dimensional changes. These can be caused by the absorption of water or by thermal expansion, and while the changes are not necessarily significant in an all-acetate product, they are serious when the material is used in combination with non-plastic materials such as glass or metal. The wall thickness of the acetate must then be sufficient to stand up under the strain developed by the differential expansion, or the assembly must be such as to allow for some slight shifting of the plastic component. In general, molded acetate is recommended for applications which are subject to relatively low loads and which can tolerate a slight shrinkage on aging. It has good resistance to organic solvents, but is disintegrated by 10% caustic soda solutions, nitric acid and 30% sulfuric acid.

Typical uses include toys, automotive and radio knobs, business machine keys, brush backs, sun glass goggles and frames, fluorescent light supports, coil spools and contact bases. The high transparency of film and sheet stock (81 to 88% in thicknesses of 0.101 to 0.250 in.) makes it highly useful for packaging and glazing materials, formed containers, price tags, playing cards and lampshades.

Cellulose acetate butyrate resembles cellulose acetate in its toughness, impact strength and ease of processing. It has, however, greater dimensional stability, partly because it is half as hygroscopic, partly because it requires a smaller amount of plasticizer to obtain a given degree of flow. For the smaller the amount of plasticizer used in a compound, the better it is retained. Also, the plasticizers used with butyrate are of a higher boiling point and have a greater degree of compatibility with it than the acetate plasticizers have with acetate. Despite the material's superior dimensional stability, it still is subject to cold flow as acetate is, and its recommended applications, whether alone or in combination with other materials, are qualified in the same way.

Typical uses include steering wheels, handset telephone base housings and dial number plates, film spools, irrigation tubing, toothbrush handles and brush backs, and various electrical items. The material is also sufficiently transparent to be used for demonstration models. Chemically, butyrate has greater resistance than acetate to dilute acids, bases and salt solutions in water, but not as good resistance to organic solvents.

Cellulose nitrate, despite the fact that it was the first synthetic plastic made, still retains an active place in the market after 75 years. This should serve to dispel a not uncommon notion that as newer types of plastics are synthesized they displace the older ones entirely.

Cellulose nitrate is tougher than either acetate or butyrate. While it cannot be molded from powder in cavities because it decomposes above 250 F, it is fabricated with great ease in the form of sheets, rods and tubes. It is also notable for its dimensional stability and resilience. Its chief drawback is its high flammability in thin sections. Nevertheless, with the taking of proper precautions, it is used safely even in film form (commercial motion picture film) and as a coating for fabrics (pyroxylin fabrics). Other important uses are spectacle frames, fountain pens, drawing instruments, toothbrush handles, white piano keys, billiard and ping-pong balls, and mallet heads.

The material is often called nitrocellulose, but this term is more accurately applied to compositions of higher nitrogen content which are not used as plastics. It has good resistance to sulfuric acid up to 30% concentrations, to 10% nitric and hydrochloric acids, and to less than 1% solutions of caustic soda. It is attacked by concentrated ammonia solutions and dissolves in the lower alcohols.

Cellulose propionate, another cellulose ester, has the characteristic toughness and impact strength of the cellulosics, along with their low resistance to cold flow, so that it, too, is recommended for applications involving relatively low load. It likewise has good dimensional stability and is easily molded; products with a fine surface finish are obtained in a short cycle. Perhaps because of its higher price, together with its fairly recent appearance on the market, its applications have been limited up to the present to such items as desk sets, automobile

Electrical Properties of Thermoplastics

Type	Dielectric Strength, Short Time (Volts/Mil)	Dielectric Constant		Power Factor	
		60 Cycles	10^6 Cycles	60 Cycles	10^6 Cycles
Acrylic	450-500	3.5-4.5	2.7-3.2	0.04-0.06	0.02-0.03
Cellulose Acetate	250-365	3.5-7.5	3.2-7.0	0.01-0.06	0.01-0.10
Cellulose Acetate Butyrate	250-400	3.5-6.4	3.2-6.2	0.01-0.04	0.01-0.04
Cellulose Nitrate	300-600	7.0-7.5	6.4	0.09-0.12	0.06-0.09
Cellulose Propionate	400-450	—	3.35-3.55	—	0.02-0.022
Ethyl Cellulose	450-500	—	2.8-3.9	—	0.01-0.06
Nylon	385-470	4.1-10.7	3.4-4.5	0.014-0.19	0.04-0.14
Polyethylene	460	2.3	2.3	<0.0005	<0.0005
Polystyrene	400-700	2.45-3.5	2.45-3.1	10^{-5}-10^{-3} (a)	10^{-4}-15^{-3} (a)
Polyvinyl Chloride and Copolymers					
Rigid	425	3.3-3.2	3.0-3.1		
Elastomeric	300-400	8-11	—	0.06-0.13	—
Polyvinylidene Chloride	350	4.5-6.0	3.0-4.0	0.03-0.045	0.045-0.065
Polytetrafluoroethylene	480	2.0	2.0	<0.0002	<0.0002

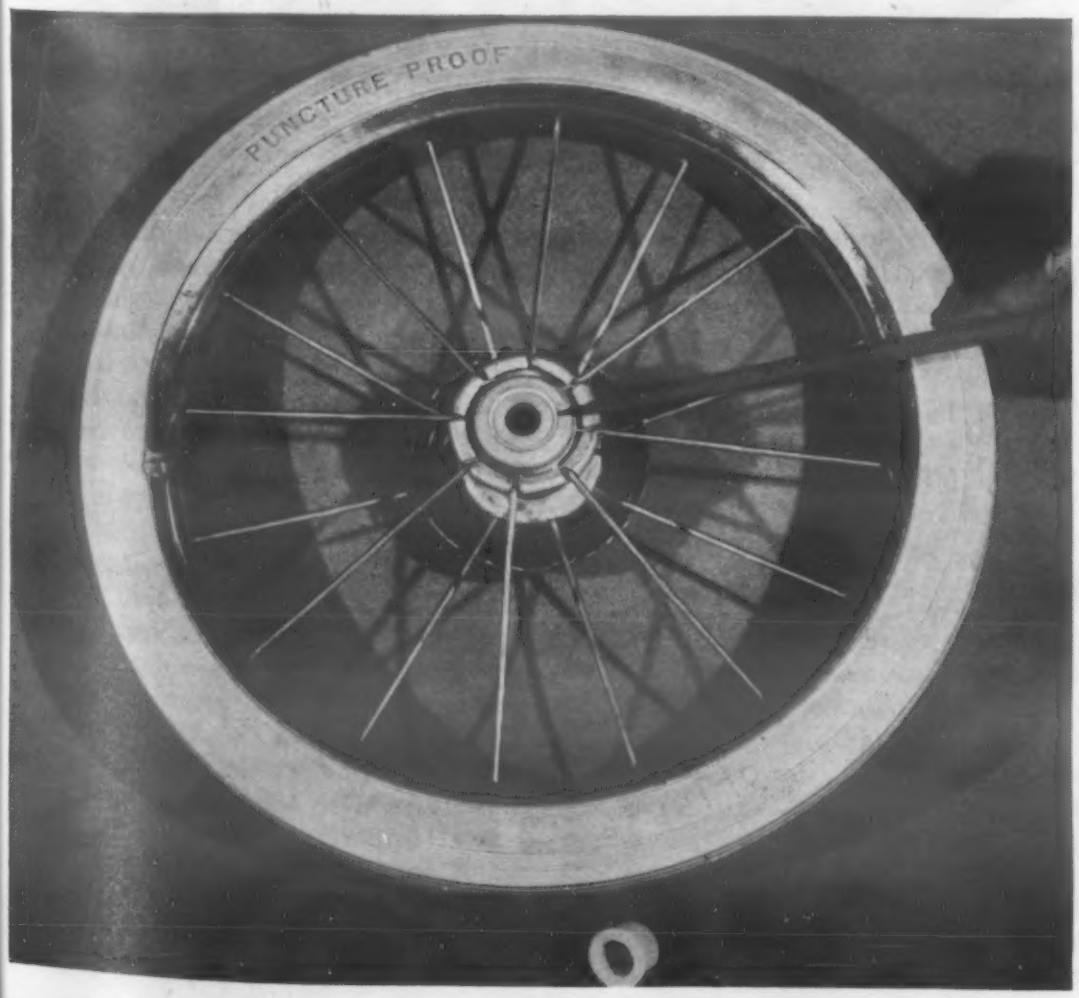
(a) Higher figure for modified polymer

escutcheons and bezels, and telephone base housings.

Ethyl cellulose is outstanding among all the thermoplastics for its toughness and high impact strength, even at temperatures as low as −40 F. It also has a low specific gravity and excellent dimensional stability over a wide temperature and humidity range, combined with good dielectric properties. One grade has a heat distortion temperature ranging up to 190 F at 264 psi. fiber stress. Ethyl cellulose has good resistance to weak acids and alkalies, but is attacked by some common organic solvents.

Typical applications are vacuum cleaner housings and wands, flashlight cases, refrigerator breaker strips, toilet seats and tool handles. Hot-melt solutions are used for applying protective coatings to products such as machine parts for storing or shipping purposes. The parts are simply dipped into the solution, and the coating effectively seals them. It is easily cut and stripped off when it is no longer required. Ethyl cellulose film has valuable qualities as a packaging material, such as flexibility at low temperatures, but its comparatively high price has limited its full exploitation.

Nylon is tough and has high wear resistance. Used as a bearing it requires no lubrication for light loads at high speeds or moderate loads for low speeds. (Courtesy E. I. du Pont de Nemours & Co., Inc.)



Nylon

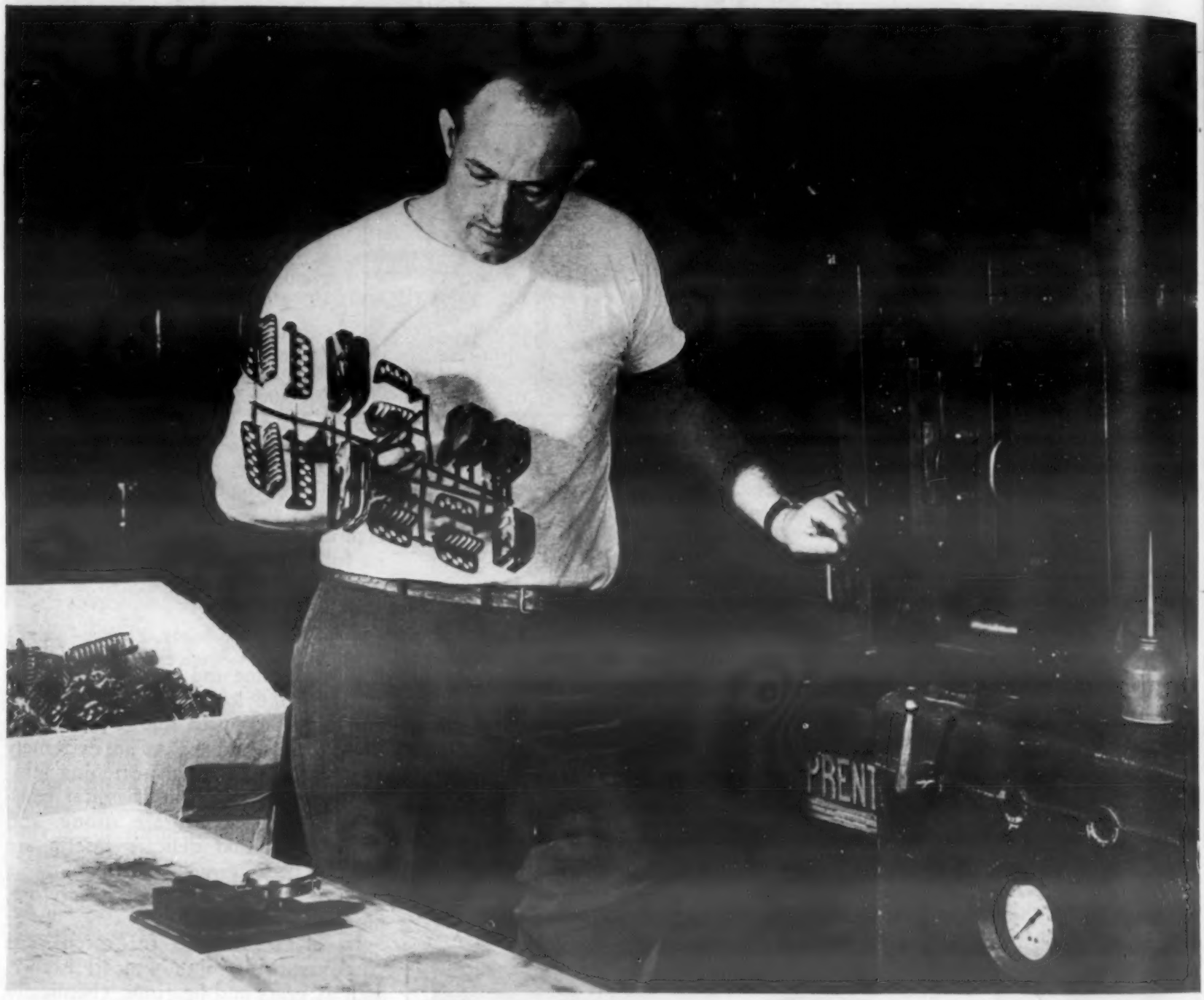
Best known as a fiber and fabric, which consume the largest part of its production, nylon also plays an important if more limited role as a molding compound. Molded parts are extremely tough and have a high softening temperature and excellent chemical resistance. Thin sections are strong, and moldings around delicate inserts are possible because nylon melts below its molding temperature and, therefore, flows freely.

Its chief uses are for mechanical parts requiring high wear resistance, such as gears and bearings; chemically resistant parts, such as valve seats and jacketing on insulated wire; and heat resistant parts, such as electrical fittings, sterilizable hypodermic needle holders and hospital utensils. Nylon tumblers and plates are virtually unbreakable. Since high pressure laminates (thermosets) are also used for gears and bearings, it may be worth comparing them. While both types are notable for silent operation, resiliency and in many cases longer life than their metal counterparts, the laminate types are more suitable for bearing heavy loads. Those made of nylon can be used for more complex designs since they are more rapidly and economically produced by injection molding, whereas the laminate gears have to be machined.

Until recently, nylon molding powder was available only in the natural off-white color. Now it is offered in 16 colors.

Polyethylene

Also known as polythene, it is the



These parts (grills and grill backs for accordion covers) are injection-molded simultaneously from styrene plastic to close limits. (Courtesy Bakelite Corp.)

lightest of all commercial plastics (sp.g., 0.92), and is outstanding for its combination of good mechanical and electrical properties. The latter are not affected by changes in humidity because of polyethylene's low water absorption and permeability. In thin sections, it remains flexible and tough to –70 F. The material is also one of the most inert of the common plastics, being particularly resistant to inorganic chemicals such as concentrated mineral acids and alkalies and oxidizing and reducing agents. Chlorinated solvents and some of the parent hydrocarbons will cause polyethylene to swell at room temperatures, but will only dissolve it at elevated temperatures.

A comparatively new material, polyethylene is finding its widest use as a packaging material (in film form and as blow molded bottles for corrosive chemicals and toiletries) and as insulation for electrical wire and cable (including co-axial cable). Other applications include fabrics (woven from extruded monofilaments), storage battery separators, ice cube trays, bowls and dishes, insulating tape, gaskets, watch straps and corrosion resistant linings for tanks, drums and the like.

Polystyrene

This plastic has been one of the most spectacular successes among all plastic materials, production having jumped from under 11 million pounds in 1944 to 140 million in 1948. Its low cost and a combination of high clarity, excellent dielectric properties, low specific gravity, resistance to water and chemicals, and unlimited color range (which it shares with the cellulosics and vinyls), have been responsible for this success. Its mechanical properties remain virtually constant over a wide temperature range, and it shows comparatively little cold flow under load. However, prolonged high stress induces crazing, so that it is not advisable to use metal inserts in molded parts.

Polystyrene is also available in modified form or in copolymers which have greater heat resistance or impact strength than standard grades. Plexene M and TA and Cerex are the trade names of some of these formulations; other polystyrene manufacturers use special number designations for them.

Some 30% of the 1948 production of polystyrene went into housewares and toys, with refrigerators as the next most important outlet. One refrigerator model uses 31 polystyrene components, totaling 17½ lb. Other makes utilize the material for evaporator doors, breaker strips, baffle trays, door

strips, shelf supports, insulation, etc. Other products which take advantage of various combinations of properties are wall tile, fluorescent lighting fixtures, clock cases, lenses and prisms, radio cabinets and stand-off and antenna insulators.

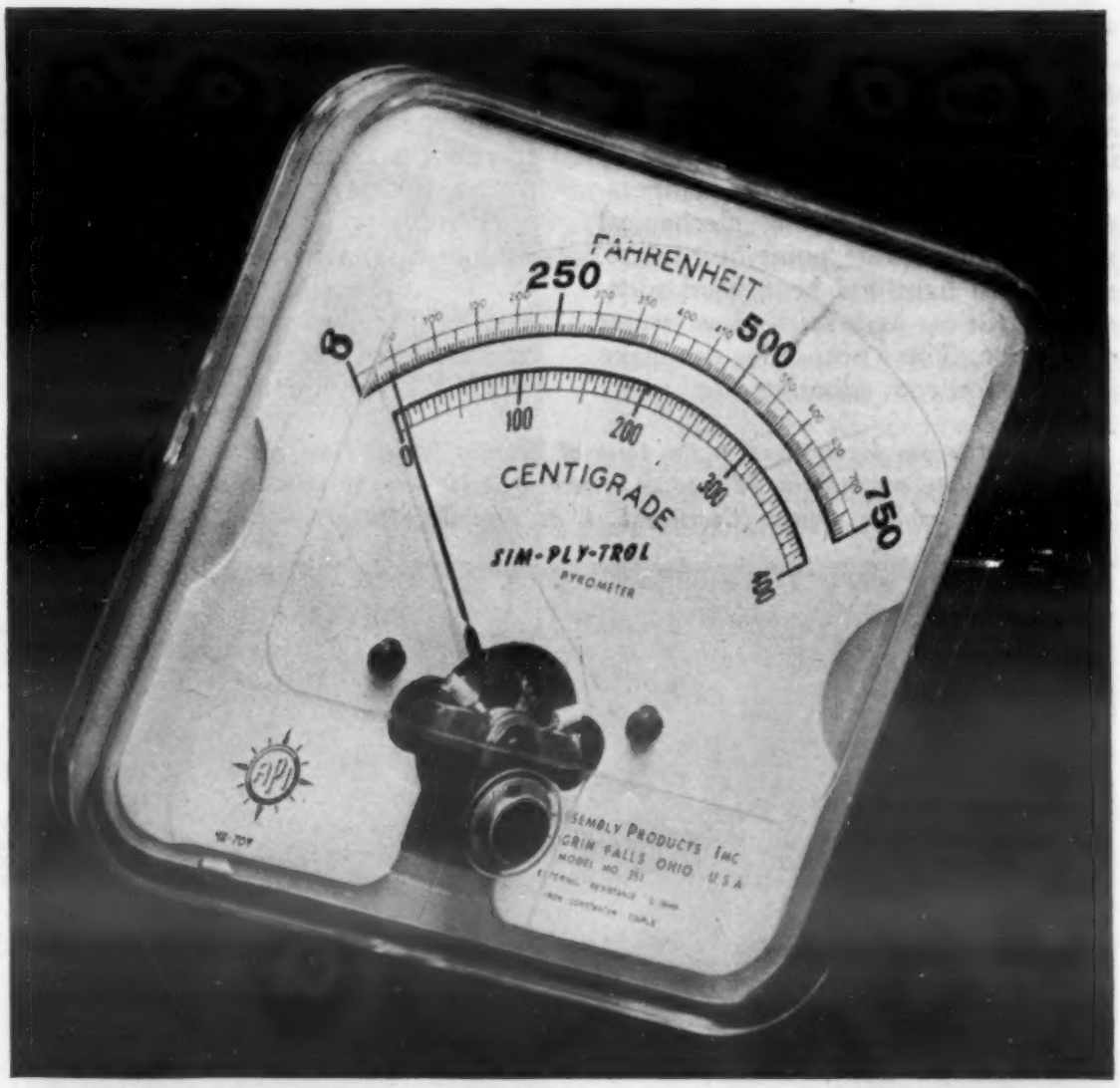
Polytetrafluoroethylene

This waxy material has the greatest chemical resistance of any of the plastics; even at high temperatures continuous service temperatures above 550 C (1022 F) are possible. Only molten alkalies and fluorine above 150 C (302 F) will attack it. The material also has an extremely low dielectric loss factor over a wide range of frequencies, high impact strength and zero water absorption. This plastic is extremely difficult to mold, and special equipment is required. Only recently has it been extruded commercially, but it is now being used as insulation on high frequency cables, as roll type capacitors for high service temperatures, and for gaskets, packings and expansion joints.

Polytrifluorochloroethylene is closely related chemically to the foregoing material. It is a derivative of ethylene and ranks as the next best plastic for chemical resistance. It is a resilient material with high resistance to cold flow and has high heat resistance. More easily molded than polytetrafluoroethylene, it can be processed by compression, transfer and injection molding and fabricated in the form of sheets, films, tubes and shaped pieces. It also lends itself to extrusion for wire insulation. Typical applications are gaskets and valve parts in chemical equipment.

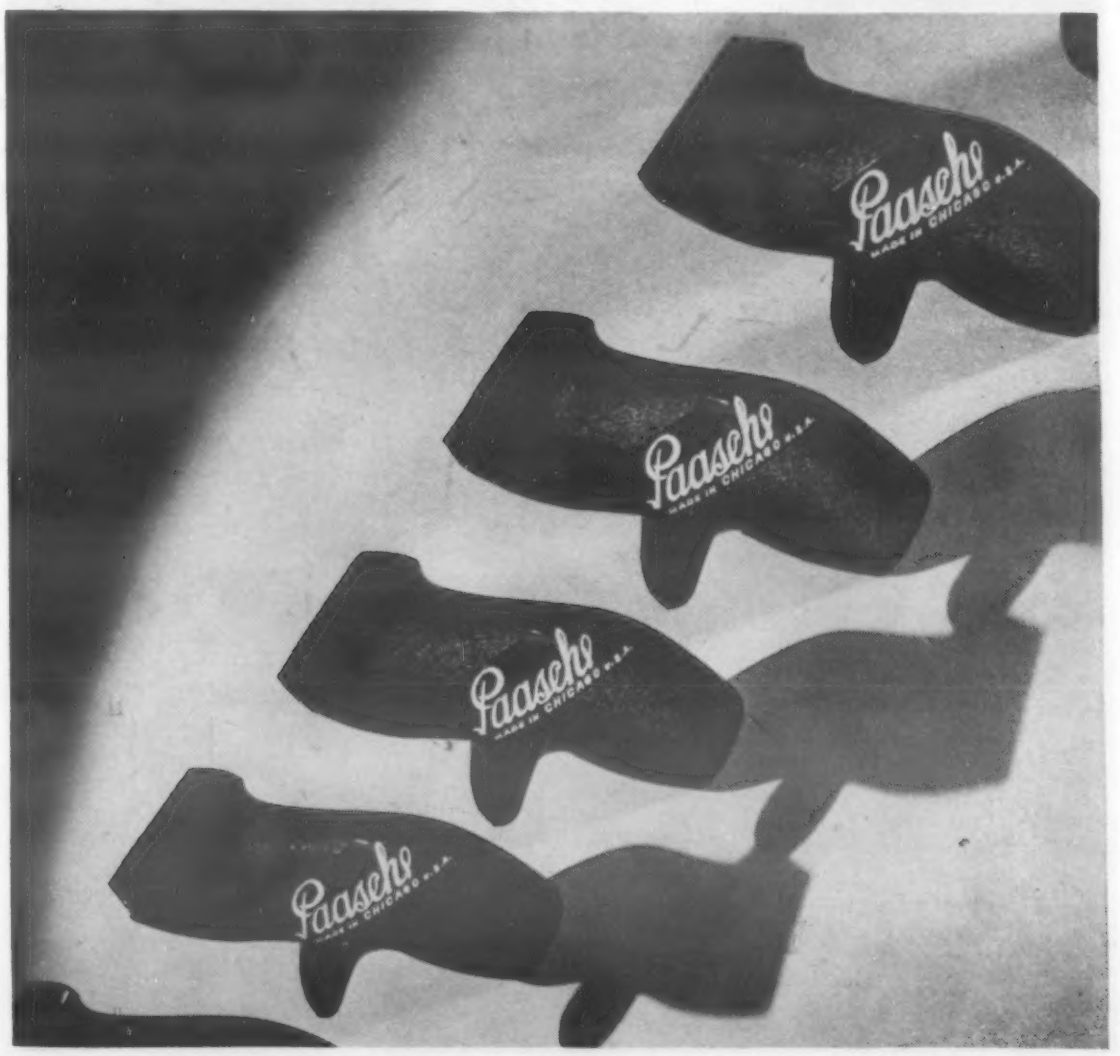
Vinyls

Polyvinyl alcohol is a resin which yields both rigid and elastomeric molded products, depending on whether it is plasticized or not. It can be cast and extruded into sheets and is capable of diversified formulations in water solutions. Its outstanding properties are resistance to hydrocarbons and chlorinated hydrocarbons, and animal and vegetable oils; low permeability to organic liquids and gases; and good abrasion resistance and toughness. The plasticized types therefore make excellent materials for hoses to convey fuel, oil or air in aircraft, automotive and instrument lines, as well as sheeting for protective clothing. Other important uses are gaskets, diaphragms and washers which are subjected to constant flexing or vibration. The material is also used as a pigment binder, as a greaseproofing agent for paper, and for



Both excellent clarity and heat resistance are gained using polystyrene for this pyrometer case. (Courtesy Koppers Co., Inc.)

A typical application of saran is this paint gun handle. (Courtesy Dow Chemical Co.)



making glassine paper transparent.

Polyvinyl butyral is best known in plasticized film form, in which it is used as the interlayer of safety glass. The film has great extensibility, toughness over a wide range of temperatures, retention of strong mechanical resistance up to the point of rupture, stability to light and heat, good adhesive qualities, and fairly low water absorption. These properties also make it an excellent adhesive for many materials and a good coating agent. Polyvinyl butyral can be modified so as to have thermosetting properties. This type is widely used in coating fabrics for raincoats, tablecloths, protective clothing, etc.

Polyvinyl chloride and copolymers, volume-wise, are the most important of the vinyl resins. Of this group of materials, polyvinyl chloride, vinyl chloride-vinyl acetate copolymer, and vinyl chloride-vinylidene chloride co-

Typical of the types of wire covered with vinyl plastics are these shown here for hearing aids, record players, and dictating machines. (Courtesy Bakelite Corp.)

Thermoplastics are widely used in the form of "plastic foam." Here is an example of how cellular cellulose acetate can be used as a core material between thin strips of metal, wood or another plastic. (Courtesy E. I. du Pont de Nemours & Co., Inc.)

polymer are the most common forms. They can be considered together because they have similar properties in many formulations which are used for the same applications. (Polyvinyl acetate alone, with certain fillers, has a limited use as a molding compound for making floor tiles and artificial leather. More commonly, it is utilized as a base for a variety of adhesives.)

The vinyl resins owe their versatility to the diversity of formulations and forms in which they can be made. As molding compounds, they are available in both rigid and elastomeric varieties; they are also extensively used as film, sheeting and fabric coatings (in which they have been rapidly displacing pyroxylin coatings). For this purpose, they are usable as water dispersions (latices) and as pastes. The latter may be dispersions in plasticizers (plastisols), or volatile solvents can be added to lower the viscosity (organosols). Furthermore, these paste resins can also be processed by injection molding or by slush casting, in which the plastic is poured into a mold and out again, leaving a thin coating over the interior walls which is first fused and then stripped from the mold.

To return to the molding compounds: variations of formulation are achieved by control of the polymerization reaction, the selection of monomers, and the choice of plasticizers, of which there are a great many. In some cases, the vinyl resin itself represents less than 50% of the composition.

The rigid types are characterized by excellent dimensional stability and are used for aircraft plotting and navigating instruments, map covers, drawing instruments, and the now familiar unbreakable phonograph records as well as the break-resistant records.

The elastomeric forms have excellent

Heavy-duty handles for saws made of cellulose acetate butyrate have good resistance to impact and weathering. (Courtesy Tennessee Eastman Corp.)

dielectric properties, good aging qualities, and excellent resistance to oil and water. Hence, their widespread use as both jacketing and insulation for wire and cable. (These can be color-coded, and one manufacturer has recently introduced a number-coded wire, the numbers being printed continuously in red on the yellow-coated wire.) Their resistance to abrasion, durability and easy cleanability have led to their increasing use as floor coverings, shoe parts (tips, welting, soles), upholstery, belts, handbags and luggage. The film is converted in increasing volume into rainwear, shower curtains, garment bags, hospital sheeting, draperies and protective clothing.

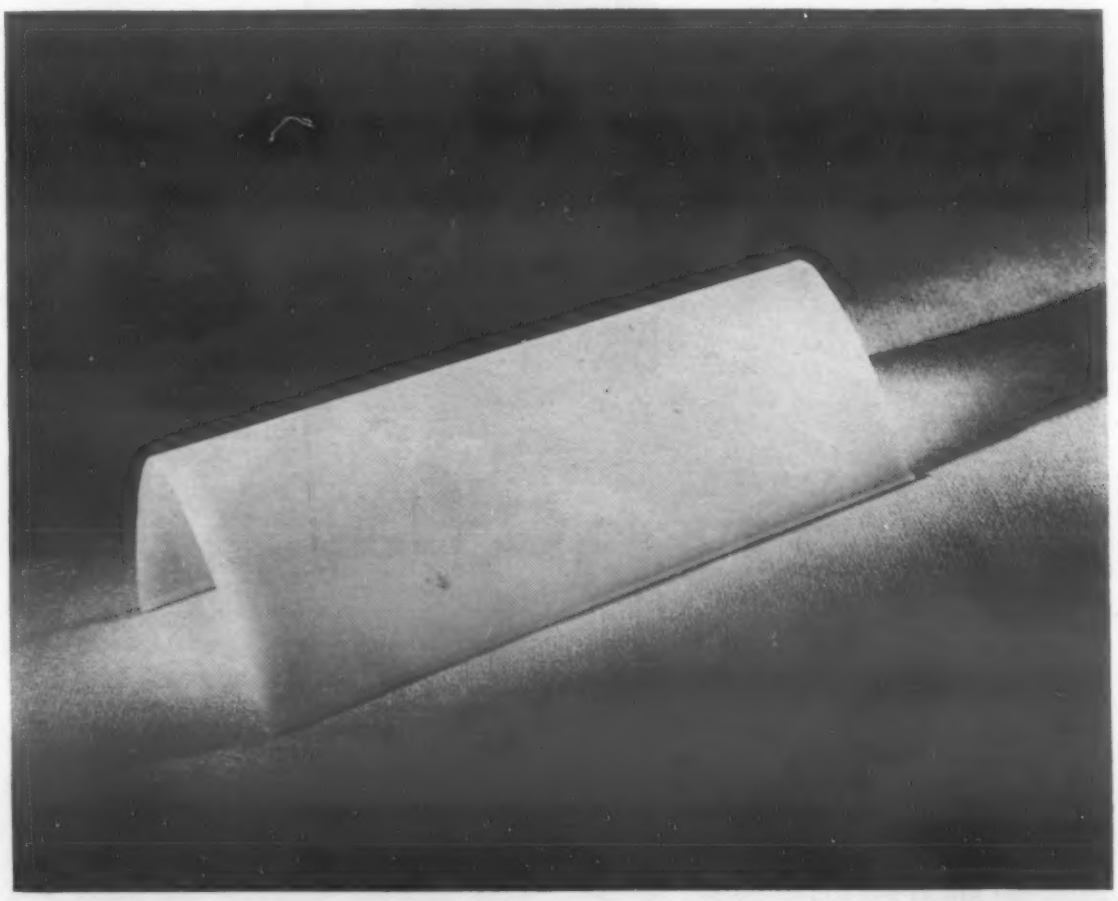
Polyvinyl formal resins have great strength and form stability. Although molding compounds have been made and their film possibilities have been demonstrated experimentally, they are largely used at present as a base for tough, water-resistant insulating enamel for electrical wire.

Polyvinylidene chloride or saran is notable for its chemical resistance, low water absorption and moisture transmission, and non-flammability. It is most widely used as an extruded filament, which is woven into fabrics for seat covers, upholstery and other applications where a high wear resistance and easy cleanability are important. Plastic screening, which is superior in many respects to the wire type, is also made from these filaments. The filaments are stretched during the extrusion process to orient the molecules, and this greatly increases their mechanical strength. Extruded pipe and tubing are important uses, such pipe being used as transmission lines for corrosive chemicals. Saran film, with its resistance to moisture and chemicals, has a significant place in the packaging field.

Molded saran parts have high impact strength, toughness and durability. Typical applications are standard pipe fittings and paint gun handles.

Expanded Plastics

A variety of plastics, both thermosetting and thermoplastic, have been treated chemically to form a lightweight cellular structure, commonly known as plastic foam. Among the thermoplastics which have been blown up in this way are polystyrene and cellulose acetate in this country, and polyvinyl formal and polyvinyl chloride abroad. While the properties of ex-



A lamp shade made of polystyrene because of its optical characteristics, rigidity and extrudability. (Courtesy Sandee Manufacturing Co.)

panded plastics vary with the base material, density, cell structure and the particular method used to create the foam, all are characterized by light weight (0.5 lb. per cu. ft. and up), high strength-weight ratio, low thermal conductivity (0.20 to 0.35 Btu./sq.ft./hr./in./F), negligible water absorption and relatively low water vapor transmission. Electrical properties, chemical resistance and heat resistance are those of the base plastic, while other properties are also governed by the density and type of cell structure.

These foams are used as refrigerator insulation and as core materials for sandwich structures finding application in aircraft, building panels and the like. They are also utilized as buoyancy materials for boats, buoys and life rafts, and in the manufacture of display, novelty and decorative items. One manufacturer has recently fabricated the polystyrene type into lengths for installation in the field on standard pipes and fittings. Custom built shapes for applications in which the temperature ranges from 175 F to —250 F are reported to be highly efficient three years after installation and requiring little or no maintenance.

Thermoplastics are sometimes used in combination with other materials. Here are shown parts composed of certain combinations of polyvinyl chloride, rubber and phenolics. (Courtesy Goodyear Rubber Co.)

Typical Uses

It is interesting to observe the uses to which thermoplastics are put in one major industry—the automotive. In some of the applications, more than one material is suitable, including thermosets, but these will be omitted here. For glazing purposes, in back lights, side curtains, head linings and upholstery, the acrylic, vinyl and nylon resins appear. In the wiring systems, polyvinyl chloride and copolymers, saran and polyethylene are used. For speedometer take-off, camshaft, oil pump and water pump gears, nylon is one of the specified materials, as it is for various bushings, door striker blocks and leaf spring pads.

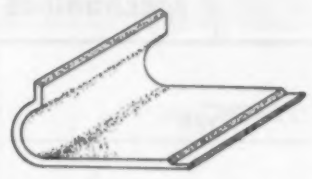
In the starting and lighting systems, three thermoplastics—polystyrene, vinyl copolymers and polyethylene—are suitable for battery separators, cell caps, wire connectors and other parts. For interior lenses polystyrene, nylon, acrylic, acetate and butyrate are specified, while acrylic and modified styrene and copolymers are favored for exterior lenses. Vinyl copolymers appear again as pedal pads, anti-squeak fender welting and steering wheels, for which butyrate and ethyl cellulose are also indicated. Pointers and dial faces are all thermoplastic — acrylic, butyrate, acetate or polystyrene. Cellulosic laminates have a place, along with thermosetting laminates, in inner door and inside quarter panels and passenger compartment partitions. Thermoplastics are further specified for arm rests and seat side shields (ethyl cellulose, butyrate); opaque sun visors (butyrate, acrylic, polystyrene); filter sun visors (acrylic, polystyrene, acetate, butyrate); horn buttons, radio parts, instrument panels and interior trim (acrylic, cellulosics, polystyrene); control knobs (cellulosics, acrylic, polystyrene, vinyl

This polystyrene kit for power tool and accessories is a typical example of the packaging uses of thermoplastics. (Courtesy Monsanto Chemical Co., Plastics Div.)

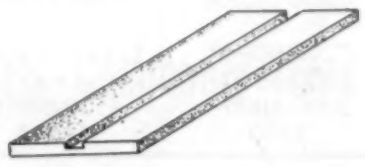
copolymers); exterior trim—strips, medallions, ornaments (acrylic).

Such extensive use of thermoplastics by the automotive industry is significant for two reasons. First, this industry is rigorous in its specifications: materials are utilized strictly for their engineering virtues, not for novelty appeal. Secondly, it is a hard bargainer: materials must justify themselves in price as well as in performance.

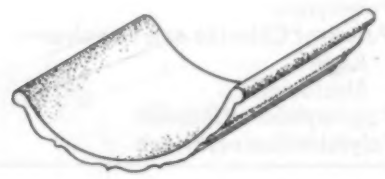
OUTSIDE CORNER TRIM
(ACETATE-BUTYRATE)



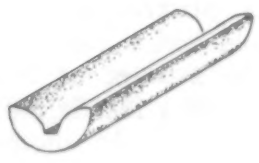
REFRIGERATOR BREAKER STRIP
(POLYSTYRENE)



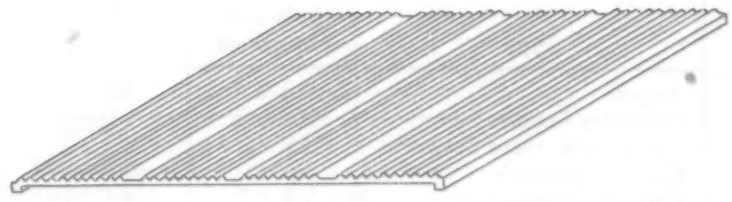
CENTER GROOVE STRIP
(POLYETHYLENE)



LIGHT DIFFUSING PANEL
(POLYSTYRENE)



BUMPER STRIP
(VINYL COPOLYMER)



LIGHT DIFFUSING PANEL
(POLYSTYRENE)

TUBING
(CELLULOSE ACETATE)

WIRE COATING
(VINYL COPOLYMER)

Some typical extrusions that can be made with thermoplastics. (Courtesy General Electric Co.)

Processing Characteristics

While the thermosetting plastics are compression or transfer molded, the thermoplastics are largely processed by injection and extrusion molding. In injection molding, the resin is heated to plasticity in a cylinder at a controlled temperature and forced under a pressure of 10,000 to 50,000 psi. into a cool, closed mold, which is clamped under a pressure of 3 to 10 tons psi., where the part sets. The molding cycle is much shorter than that of thermosets, for which the mold must first be heated and then cooled before the part is ejected. This means that the labor cost per unit is much lower in injection molding. So is the cost of cleaning and finishing the parts, and the cost of the molds. Finally, there is a great economy in injection molding due to the fact that scrap material, both rejects and the material which is cut off from the molded parts (sprue, runners and gates), can be used again, whereas thermoset scrap is usually thrown away.

It has been computed that to obtain the same hourly rate of production on a certain small part as could be obtained from a 2-cavity injection mold, a 20-cavity compression mold would be required. If the same part were reproduced in a thermosetting material, it would need a 10-cavity compression mold to equal the rate of production of that same 2-cavity injection mold. It has, in fact, been found practicable to produce by injection molding parts which were too costly for compression molding or which entailed too great technical difficulties. The low processing cost also often counteracts the high raw material cost of such materials as nylon to a point where a product can be put on the market economically. A case in point is a hypodermic needle case, of which 192 are produced in one multi-cavity mold.

Another procedure which is possible with injection molding is the covering of metal cores with plastic, as is done with automobile steering wheels. In this process, too, molded screw threads, undercut sections and side holes are easily produced. Two-color pieces can be made by successive injection molding operations (double shot molding), the part shot first becoming an insert for the second molding. Many automotive parts and business machine keys are being molded in this way.

Recently, the Hydraulic Press Manufacturing Co. developed a press containing two injection units for the Friden Calculating Machine Co. in which the two-color molding is achieved automatically. In this press the key top shelves are molded first and the core material is injected in the second stage.

The major limitations of injection molding are the size of piece which can be produced, the impossibility of obtaining heavy sections, and the excessive cost of large and heavy pieces. However, so-called standard type injection machines (built on the principle briefly outlined above) have been steadily developed with increasing capacity. Some types are now rated at 48 oz. Newer types are being designed

Mechanical Properties of Thermoplastics

Type	Impact Strength (Izod, ft.-lb./ In. Notch)	Tensile Strength (Psi.)	Flexural Strength (Psi.)
Acrylic	0.4-0.5	7500-10,000	13,000-17,000
Cellulose Acetate	0.4-5.2	1900-8500	2000-16,000*
Cellulose Acetate Butyrate	0.6-5.4	1900-6800	1500-8300*
Cellulose Nitrate	5.0-7.0	7000-8000	9000-11,000
Cellulose Propionate	0.5-11.0	2200-6500	3000-10,500*
Ethyl Cellulose	2.0-8.0	2000-8000	4000-11,000
Nylon	1.5->16	7400-10,900	3800-14,600*
Polyethylene	Does not break	1300	—
Polystyrene	0.25-1.2	5000-10,000	8000-17,000
Polyvinyl Chloride and Copolymers			
Rigid	0.4-0.75	7200-9000*	12,600-14,500*
Elastomeric	—	1400-3000	—
Polyvinylidene Chloride	0.3-1.0	3000-5000	4500-6000*
Polytetrafluoroethylene	2.5-4.5	1800	1600*

Stress at yield

Water Absorption of Thermoplastics

Type	% Water Absorption
Acrylic	0.3-0.4
Cellulose Acetate	2.2-6.5
Cellulose Acetate Butyrate	1.2-2.2
Cellulose Nitrate	1.0-2.0
Cellulose Propionate	1.2-1.7
Ethyl Cellulose	0.8-1.8
Nylon	0.4-2
Polyethylene	<0.01
Polystyrene	0.03-0.3
Polyvinyl Chloride and Copolymers, Rigid	0.07-0.08
Elastomeric	0.40-2.25
Polyvinylidene Chloride	<0.1
Polytetrafluoroethylene	0.00
Polytrifluorochloroethylene	0.00

which will have, it is reported, 60-, 80- and 160-oz. capacities.

In extrusion molding, the material is also heated in a cylinder at a controlled temperature, but instead of being forced into a closed mold it is driven by a rotating screw through a die, the opening of which is approximately the shape of the part desired; and the part is not a single piece but a continuous tube, rod, film, sheet or profile which is cut to length. (Sheet and film are also produced by casting and calendering.) Certain simple shapes, such as fluorescent light shields, can be extruded and cut to size much more economically by extrusion than injection molding, since the extrusion die is much cheaper than an injection mold and production is more rapid. Extrusion is also the standard means of coating wire and cable, the plastic being applied in a crosshead attached to the machine.

A more specialized technique for converting thermoplastics into finished products by means of air pressure and heat is called blow molding. This makes use of either the raw resin or the already processed material in the form of sheet or tube. In one procedure a tube of the material is placed in a cold split mold and expanded to fill its contours, or a sheet of it is clamped on the rim of a female mold and blown down into it. In another procedure, the resin is the starting material, and it is first given the approximate shape of the product by melting it and either injection molding it around a hollow insert or extruding a tube of it. The former is given its final shape in a cold split mold; the latter is formed within a blow mold brought up to the extruder. Blow molding is used chiefly to produce bottles (flexible polyethylene bottles are now being produced in largest volume), hollow toys, Christmas tree balls and novelties.

The production of finished products by fabrication methods other than molding is even more extensive with thermoplastic materials than with thermosets, where it is confined to the laminates. Thermoplastic sheet stock can not only be worked by all the common machine operations—sawing, turning, blanking, etc.—but can also be bent or stretched into diverse shapes. Familiar examples are cellulose acetate packages and acrylic display fixtures and forms and aircraft canopies.

Dipping, or solvent molding, is another specialized thermoplastic technique. Here the plastic is used in the form of a solution, gel (suspension), paste or hot melt, and by controlled repeated immersions a finished product can be given a coating which greatly increases its strength (bowling pins, flower pots, etc.), or the coating can be applied to a mold and then stripped off. In this way it is possible to produce shapes which either cannot be produced at all by other techniques or only at a prohibitive die cost. Dolls and other toys, bathing caps and vials are some of the items made commercially.

The fabrication of plastic films is a whole field to itself. In 1949, productive capacity (including that of cellophane) was well over 350,000,000 lb. Next to cellophane, which accounted for some 60% of this figure, polyethylene and polyvinyl chloride and its copolymers were most important in point of volume, but almost all the common thermoplastics play a part and many other types show promise of usefulness in film form. While packaging represents the greatest single outlet, there are many other important products, such as shower curtains, drapes, garment bags, inflatable toys and rafts, etc. Without the development of heat-sealing methods, the enormous expansion of film uses would not have been possible. At the same time, the art of controlling the properties of a film or combination of films has gone so far as to make it a custom product, although standard types are suitable for many purposes.

While components of thermosetting plastics are generally assembled by mechanical means, thermoplastic fabrication calls for a great deal of assembly by cementing and heat "welding" techniques. The former is more widely applicable, with solvent types of cements, usually of the same composition as the plastic being bonded, in most common use.

Prices of Molding Compounds

Type	Specific Gravity	Cost/Lb.	Cu. In./Lb.	Cu. In./$*
Acrylic	1.18-1.20	70¢-$1	23.4-23.0	33.4
Cellulose Acetate	1.27-1.37	37-49¢	21.8-20.2	58.8
Cellulose Acetate Butyrate	1.15-1.24	56-61¢	24.0-22.4	42.8
Ethyl Cellulose	1.07-1.18	58-66¢	25.9-23.4	44.6
Nylon	1.14	$1.60-4.50	24.2	15.1
Polyethylene	0.92	46-52¢	30.1	65.4
Polystyrene	1.05	26-33¢	26.3	101
Polyvinyl Chloride and Copolymers	1.2-1.6	43-83¢	23-17.3	53.4
Polyvinylidene Chloride	1.65-1.75	36-59¢	16.8-15.8	46.6

**Value based on lowest specific gravity and cost given here. The price ranges are typical, not complete, varying also with the quantity purchased.*

Materials Engineering File Facts

NUMBER 188
March, 1950

MATERIALS: Steel

Properties of Steels Commonly Used for Plastic Molds

Mold steels in table below are listed roughly from left to right (1 to 6) in increasing order of core strength after heat treatment, and also in order of hardness as annealed. The easier-hobbing alloys, steels 1 and 2, do not possess as high core strength after heat treatment as does steel 3, which requires more pressure for hobbing, and which may require extra annealing before the desired cavity can be obtained. The steels used in machined cavities must be carefully annealed for optimum machinability. Since freedom from inclusions is an absolute prerequisite, high sulfur types are not desirable. It is most desirable that mold steel be of electric furnace quality.

Steel, % Composition	C, 0.10 Mn, 0.20 (1)	C, 0.10 Mn, 0.50 Ni, 1.25 Cr, 0.60 (2)	C, 0.15 Mn, 0.50 Ni, 1.25 Cr, 0.60 (3)	C, 0.10 Mn, 0.40 Ni, 3.50 Cr, 1.50 (4)	C, 0.50 Mn, 0.40 Ni, 3.50 Cr, 1.50 (5)	C, 0.90 Mn, 1.60 Si, 0.25 (6)
Method of Making Cavity	Hobbing	Hobbing	Machining cavities and forces	Machining cavities and forces	Machining cavities and forces	Machining cavities and forces
Application	Intricate molds requiring extreme hobability	Plain hobbed cavities at medium molding pressures; general	Same as #2 but for machined rather than hobbed cavities and forces	Very large cavities, high molding pressures, very long runs, highly abrasive plastics; also for forces	Machined cavities which must hold size and shape, intricate cavities and forces	Cavities which must hold accurate size and shape, intricate cavities and forces
Method of Hardening	Case-hardening	Case-hardening	Case-hardening	Deep-hardening case	Oil-hardening	Oil-hardening
Distortion in Hardening	Slight	Slight	Slight	Trace	Negligible in smaller sizes	Negligible in smaller sizes
Hobability	Excellent	Good	Moderate (not ordinarily hobbed)	Difficult	Difficult	Difficult
Machinability	Soft for cold hobbing; machines stringy	Soft for cold hobbing; machines stringy	Like SAE 1020	80% of SAE 1020	80% of SAE 1020	Similar to plain carbon tool steel
Core Strength	Moderate (elastic limit about 30,000 psi.)	Good (tensile strength about 110,000 psi., yield point about 80,000 psi., depending on quench and size of section)	Good (tensile strength about 125,000 psi., yield point about 85,000 psi., depending on quench and size of section)	Excellent (tensile strength about 165,000 psi., yield point about 135,000 psi.)	Excellent; high in compression	Extremely high in compression
Case Hardness	Rockwell C-62	Rockwell C-62	Rockwell C-62	Rockwell C-62	Rockwell C-58/59	Rockwell C-62
Wear Resistance	Fairly good	Good	Good	Excellent	Good	Good

Adapted from data in The Society of Plastics Industry, Inc., Handbook

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TA-153 5

Materials Engineering File Facts

NUMBER 189
March, 1950

MATERIALS DATA SHEET

Non-Heat-Treatable Wrought Aluminum Alloys

Absence of the precipitation-hardening mechanism makes these alloys dependent upon work hardening by cold reduction for increased strength properties. For this reason, the highest strengths obtainable in the aluminum system are not to be found in this group. However, this group contains the most highly corrosion resistant aluminum alloys, with the exception of the clad sheet alloys.

Typical Properties

TYPE	2S	3S	52S	4S	56S
COMPOSITION, % (Excluding Impurity Limits)	Al, 99.0 min.	Mn, 1.0-1.5	Mg, 2.2-2.8 Cr, 0.15-0.35	Mn, 1.0-1.5 Mg, 0.8-1.3	Mn, 0.05-0.20 Mg, 4.7-5.6 Cr, 0.05-0.20
PHYSICAL PROPERTIES					
Density, Lb./Cu. In.	0.098	0.099	0.097	0.098	0.095
Melting Range, F	1190-1215	1190-1210	1100-1200	1165-1205	1055-1180
Thermal Cond., Btu./Hr./Sq. Ft./Ft./F, @ 77 F (Annealed)	128	111	79.8	94.3	67.7
Coeff. of Exp. per F:					
68 to 212 F	13.1×10^{-6}	12.9×10^{-6}	13.2×10^{-6}	13.3×10^{-6}	13.5×10^{-6}
68 to 572 F	14.2×10^{-6}	13.9×10^{-6}	14.3×10^{-6}	14.4×10^{-6}	14.6×10^{-6}
Spec. Ht., Btu./Lb./F, @ 212 F	0.22	0.22	0.22	0.22	0.22
Elect. Res., Microhm-Cm. @ 68 F:					
Annealed	2.92	3.45	4.93	4.10	5.94
Hard (H18 or H38)[2]	3.02	4.31	4.93	4.10	6.39
MECHANICAL PROPERTIES					
Mod. of Elasticity, Psi.	10.0×10^6	10.0×10^6	10.2×10^6	10.0×10^6	10.3×10^6
Tensile Str., 1000 Psi.:					
Annealed (0)	13.0	16.0	27.0	26.0	42.0
Half Hard (H14 or H34)[1]	17.5	21.5	37.0	34.0	—
Hard (H18 or H38)[2]	24.0	29.0	41.0	40.0	60.0
Yield Str., 1000 Psi.:					
Annealed (0)	5.0	6.0	12.0	10.0	22.0
Half Hard (H14 or H34)[1]	16.0	19.0	31.0	27.0	—
Hard (H18 or H38)[2]	22.0	26.0	36.0	34.0	50.0
Elong. in 2 In., % (1/16-In. Sheet, 1/2-In. Bar):					
Annealed (0)	35, 45	30, 40	25, 30	20, 25	—, 35
Half Hard (H14 or H34)[1]	9, 20	8, 16	10, 14	9, 12	—, —
Hard (H18 or H38)[2]	5, 15	4, 10	7, 8	5, 6	—, 15
Hardness, Bhn.:					
Annealed (0)	23	28	45	45	—
Half Hard (H14 or H34)[1]	32	40	67	63	—
Hard (H18 or H38)[2]	44	55	85	77	—
Fatigue Str., (End. Limit), 1000 Psi.:					
Annealed (0)	5.0	7.0	17.0	14.0	20.0
Half Hard (H14 or H34)[1]	7.0	9.0	18.0	15.0	—
Hard (H18 or H38)[2]	8.5	10.0	19.0	16.0	22.0
Shear Str., 1000 Psi.:					
Annealed (0)	9.5	11.0	18.0	16.0	26.0
Half Hard (H14 or H34)	11.0	14.0	21.0	18.0	—
Hard (H18 or H38)	13.0	16.0	24.0	21.0	32.0
FABRICATING PROPERTIES					
Annealing Temp., F	650	775	650	755	650
Hot Working Temp. Range, F	500-950	500-950	500-950	500-950	500-950
Machinability[3]	B	B	B	B	B
	Generally, these alloys have good machining characteristics.				
Relative Weldability:[3]					
Torch	A	A	B	B	C
Inert Arc	A	A	A	A	C
Elect. Res.	A	A	A	A	A
CORROSION RESISTANCE					
Resistance to Atmosphere	High resistance to rural, industrial and marine atmospheres.				
Resistance to Chemicals	Good resistance to most neutral or nearly neutral fresh waters; sea water; many food stuffs; organic acids and anhydrides; alcohols; aldehydes; esters; ketones; oils, gasoline, greases, waxes, and other petroleum derivatives; ammonia and ammonium compounds; nitric acid above 82%; essential oils; amides; nitroparaffins; coal tar derivatives; naval stores products; hydrogen peroxide; and many neutral aqueous inorganic salt solutions. Resistance to corrosion may be affected by certain contaminants in the chemical products.				
AVAILABLE FORMS	Sheet, plate, wire, rod, bar.			Sheet, plate, drawn tubing, pipe.	Rod, wire, rivets.
	Rivets, forgings, impact extrusions.	Extruded shapes, tubing, forgings.	Drawn tubing and pipe.		
USES	Cooking utensils, heat exchangers, pressure and storage tanks.		Bus and truck bodies, aircraft tubing, milk crates, fan blades, kitchen cabinets.	Hydraulic tubing for commercial vehicles.	Cable sheathing, rivets for riveting magnesium.
	Chemical equipment, reflectors.	Ductwork, truck panels.			

NOTES: [1] *H14 (strain hardened to "half-hard" condition) for 2S and 3S; H34 (strain hardened to "half-hard" condition and stabilized) for 4S and 52S.*
[2] *H18 (strain hardened to "hard" condition) for 2S and 3S; H38 (strain hardened to "hard" condition and stabilized) for 4S, 52S and 56S.*
[3] *Letter A indicates most favorable property, B less favorable, etc. Values relative to aluminum system only.*

Prepared with the assistance of Aluminum Co. of America and Reynolds Metals Co.

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New Materials and Equipment

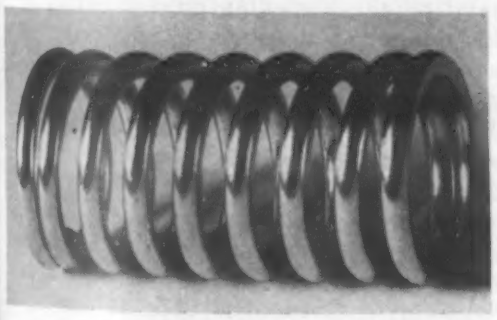
CONTENTS

Iron and Steel

Age-Hardenable Stainless Steel

A precipitation-hardening stainless steel, claimed to have the strength and hardness of high carbon spring steels and corrosion resistance close to that of 18:8, has been developed by *Armco Steel Corp.*, Middletown, Ohio. Available in sheet, strip, plate and wire, 17-7 PH Stainless Steel serves as a companion grade for 17-4 PH announced last year (MATERIALS & METHODS, Sept. 1949, page 116) and available in bars and forging billets.

The new alloy is particularly recommended for use in the chemical, petroleum,



Springs are one of the most promising applications for the new Armco stainless steel, 17-7 PH.

textile and food-producing industries for springs, pressure tanks, diaphragms and disks, conveyor parts, spring clips, washers and similar parts. It is also claimed to be suitable for many applications in the aircraft and automotive industries, where the equality of its tensile and compressive yield strengths is of particular advantage. Nominal composition of 17-7 PH is 0.07 carbon, 17.0 chromium, 7 nickel and 1.0% aluminum.

In the soft temper condition, the alloy can be severely formed or drawn and welded by resistance, metallic-arc, and inert gas shielded-arc methods. After fabrication, its full strength and hardness are developed by heating at 1400 F for 30 min., air cooling and reheating to 900 to 950 F for 30 min., followed by air or furnace cooling. This treatment produces tensile strengths of 185,000 to 205,000 psi., yield strengths of 160,000 to 190,000 psi., and hardness of Rockwell C 40 to 45.

Hard temper 17-7 PH sheet and strip have fabricating properties equal to those of Type 301 full-hard temper stainless steel. In this condition it can be punched, blanked, flanged and dished to a moderate degree. Tensile strengths over 255,000 psi. and Rockwell hardnesses over C51 are developed by heating to 900 F for 1 hr. and air or furnace cooling.

Hard temper 17-7 PH wire can be wrapped on its own diameter. Typical properties after hardening are: tensile strength, 260,000 to 345,000 psi.; yield strength, 250,000 to 340,000 psi.; Rockwell hardness, C50 and up; and proportional limit in tension, 150,000 to 180,000 psi. This wire is also available mill treated at 850 F, designated extra hard temper.

Ductile Cast Iron

Ductile Cecolloy, a high-carbon cast iron with graphite in spheroidal form, is being marketed by *Chambersburg Engineering Co.*, Chambersburg, Pa.

The material is treated with magnesium to transform the graphite from the normal flake form to spheroidal form, thus retaining self-lubricating properties and much of the vibration-dampening properties of cast iron, at the same time virtually eliminating the inherent weakness of normal cast iron which results from the notch effect of flake graphite. Machinability of Ductile Cecolloy is said to be equal to or better than that of cast steel, and good finishes are easily attained.

Range of obtainable mechanical properties as cast is as follows:

Tensile Strength—60,000 to 80,000 psi.
Yield Strength—40,000 to 60,000 psi.
Elongation—0 to 15%
Modulus of Elasticity—22 to 25×10^6 psi.

Although the cost of this iron lies between the cost of gray iron and cast steel, it is claimed that weight reduction made possible by its high strengths can result in economies over cast iron construction.

●

Nonmetallics, Coatings

Metal Ceramics

Metal ceramic materials, having high thermal shock resistance, high strength at elevated temperatures and good abrasion resistance, have been developed by the *Special Metals Div.* of *P. R. Mallory & Co., Inc.*, 3029 E. Washington St., Indianapolis 6, Ind. In addition, these materials are machinable, suitable for electroplating, and have intermediate electrical and thermal conductivity.

Possible uses for these metal-ceramics in-

New Materials and Equipment
(CONTINUED)

clude: dies for hot forming, containers for high temperature furnace work, jet engine and rocket components, flux-resistant welding and brazing fixtures, electrical contacts, and spark plug electrodes. The company is now accepting sample orders for small pieces of these materials for evaluation purposes.

Protective Vinyl Coating

A vinyl resin formulation, known as Dampney Vinyl Coating and recommended for wet or dry service over an operating temperature range of −40 to 160 F, has been developed by *Dampney Co. of America,* Hyde Park, Boston 36, Mass.

The protective coating compound is said to be resistant to alkalis and mineral acids, to be insoluble in alcohols, greases, oils and aliphatic hydrocarbons, and to have low permeability to water vapor and low water absorption. These properties are believed to make it particularly effective in applications where metal is subject to deterioration from chemical or moisture attack.

Additional advantages of the material are its lack of taste, odor, toxicity or flammability, and the fact that it develops good adhesion to relatively smooth surfaces without heat curing. The durable coating can be supplied in clear, black or gray high-gloss finish; other colors can be formulated to meet special requirements.

ing will result from additional development work.

Representative mechanical properties of the annealed tubing are as follows:

Ultimate Strength—80,000 psi. (max.)
Yield Strength—40,000 psi. (min.)
Elongation in 2 In.—25% (min.)
Rockwell B Hardness—95 (max.)

The chemical analysis limits have been tentatively fixed as follows: 99.5 (min.) titanium, and iron limited to 0.15, silicon 0.15, magnesium 0.10, manganese 0.10, nitrogen 0.15, oxygen 0.20, and carbon 0.05%.

Expanded Metal

Availability of a new light-weight expanded metal, claimed to have the finest mesh yet produced, has been announced by *Penn Metal Co., Inc.,* 250 E. 42 St., New York City.

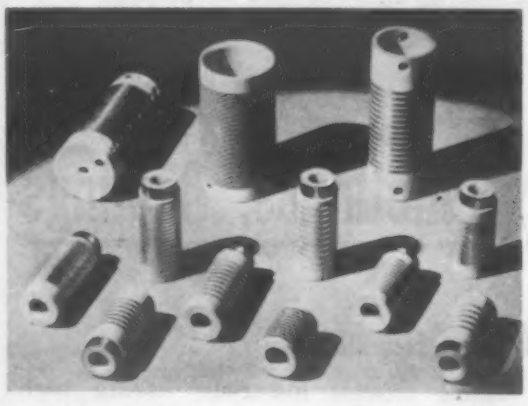
The 3/16- by ½-in. diamond pattern mesh of 22-gage metal is being produced in carbon steel, copper, aluminum and other metals. It is thought to be suitable for small screens and grilles, in radio and television sets, furniture panels, containers, and other articles where light weight is important and unusual ornamental effects desirable.

Parts and Forms

Metallized Coils

Inductance coils consisting of a spiral metal coating fired on a ceramic core are now available from *American Lava Corp.,* Chattanooga 5, Tenn. The winding directly metallized to the coil form is said to have greater inductive stability than the conventional wire winding.

When wire is wound around a coil form, there is some air space between the wire and the ceramic; this space becomes greater when heat is generated in the wire because of the difference between its temperature



Metallized windings produced by American Lava Corp. are said to offer greater inductive stability than conventional forms.

coefficient of expansion and the far lower one of the ceramic. This condition results in an unstable coil, one whose inductance may not retrace to its original value.

Firing of a spiral metal coating on the ceramic, on the other hand, assures intimate contact and the thin metal layer follows elastically the dimensional thermal changes of the ceramic. For this reason, inductances of this type are believed to be well suited for precision tuning circuits.

An example of the relative inductive stability of wire and metallized coils is furnished by the following figures: The temperature coefficient of inductance for ALSiMag 196 coil form, wound with copper wire, is 22×10^{-6} per deg. F. For an identically shaped coil form of the same material, but with the metal fired on the ceramic, it is only 10×10^{-6} per deg. F, or 54% lower.

Any of the vitreous low-loss ALSiMag compositions can be used for the coil form, selection being governed by the particular application. The company is now furnishing hand-made test samples, made to individual specifications, which permit laboratory tests and comparisons; thus, designs can be perfected and tested before production runs are ordered.

Titanium Tubing

Limited availability of Weldrawn commercially pure titanium tubing has been announced by *Superior Tube Co.,* Norristown, Pa.

The tubing is being offered in three standard tempers: annealed, half-hard and hard-drawn. At the present time, sizes range from ¾-in. dia. and 0.049-in. wall thickness down to ⅛-in. dia. and 0.010-in. wall thickness. It is expected that heavier wall thicknesses and a line of seamless tub-

Heat Treating

Hardening Compound

Development of a low-cost, quick-acting steel hardening compound called Hard-N-Deep has been announced by *Miracaloy Corp.,* 50 Broadway, New York 4.

The chromium-carbon material contains an exclusive catalyst XL-7, which is said to speed up the hardening process and allow the compound to work at relatively low temperatures. By a combination of carbonizing, nitriding and chromizing action, Hard-N-Deep produces a tough, uniform case without appreciable change in surface dimensions.

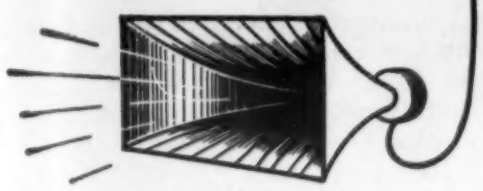
The new compound permits rapid and simple heat treating. The part to be hardened is heated to a cherry red, dipped in the compound, brought back to temperature, and quenched—a procedure requiring only a few minutes. One treatment is claimed to produce a case of about 1/32 in.; deeper penetration can be obtained by additional applications.

Electric Pit Furnace

An electric recirculating-air type pit furnace for heat-treating operations up to 1200 F has been announced by *W. S. Rockwell Co.,* 200 Eliot St., Fairfield, Conn.

The new furnace features a fan mechanism located at the bottom of the heating chamber in order to insure more uniform

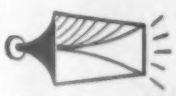
facts speak LOUDEST



At least one type of Molybdenum high speed steel is listed and promoted on a basis of equivalent and interchangeable performance with tungsten steel, by makers of high speed steel.

Users' reports of Molybdenum high speed tools *everywhere* indicate that performance at least equals and in many cases betters that of tungsten tools.

The heat treatment of Molybdenum high speed steels is basically the same as that of tungsten steels. There is nothing in the treatment to confound those who are familiar with the heat treatment of tungsten types.



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MOLY

New Materials and Equipment

circulation of heated air. The furnace is heated by a series of removable Nichrome electric heating coils completely surrounding the alloy steel basket, which rests on an alloy grid plate. The 30-in. dia. by 32-in. depth basket is equipped with two lifting

More uniform heated air circulation is attained in this new W. S. Rockwell electric pit furnace.

lugs and is guided into place in the furnace by six structural members, which prevent damage to the heating elements.

In general, the convection furnace has been designed to retain the advantages of efficiency, speed and space economy gained by basket loading for the heat treating of small batches of metal parts. It is available in capacities of 200, 300, 600 and 1500 lb. of steel per hr.

Vertical Slot Forge Furnace

A vertical slot forge furnace which utilizes a lithium atmosphere for protection against scaling up to 2400 F is being marketed by the *Lithium Co.*, 111 Sylvan Ave., Newark 4, N. J. In addition to protection from scaling during heating operations, the furnace atmosphere produces a slight coating of lithium which prevents secondary oxidation as high as 2200 F during subsequent cooling down periods.

The protective atmosphere is furnished by the lithium vaporizing chamber, a refractory-lined steel shell provided with gas burners or electric heaters and built integrally with the furnace. The chamber contains a tubular lithium vaporizer in which a cartridge of lithium compound is vaporized. The carrier gas consists of the products of combustion which pass through a precooler and condenser, then recirculate through the lithium vaporizing tube, pick-

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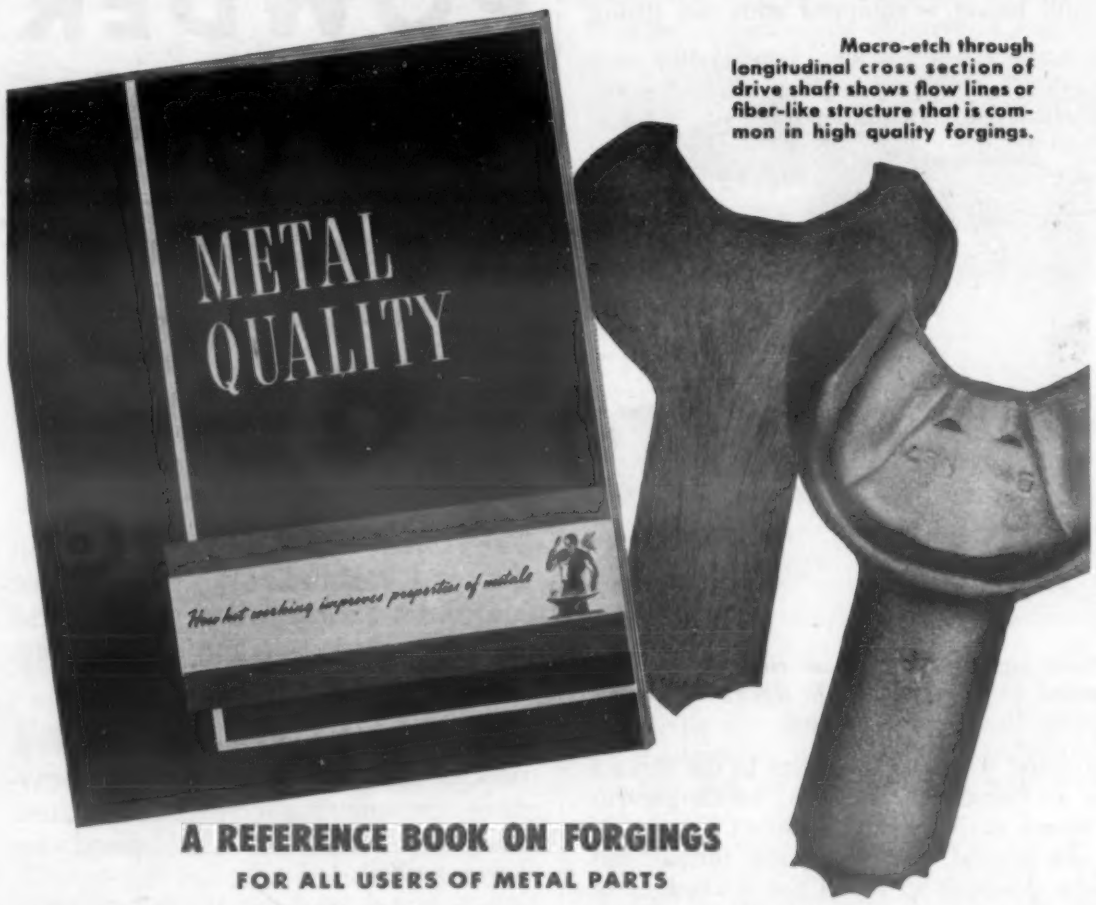


Macro-etch through longitudinal cross section of drive shaft shows flow lines or fiber-like structure that is common in high quality forgings.

A REFERENCE BOOK ON FORGINGS

FOR ALL USERS OF METAL PARTS

Sixty pages of authoritative information on metal quality as developed in forgings formed through the use of closed impression dies. Forging production techniques are described and illustrated; economic advantages of forgings are presented from the viewpoint of top management, design engineers, metallurgists and production executives. Your copy is ready. Fill in and attach coupon below to your business letterhead.

* * *

A product fortified with the metal quality found in forgings outperforms other products. Forgings' grain structure and fiber-like flow lines are controlled, directioned, and concentrated at points where the highest stress and shock occur under actual service conditions. High tensile and impact strength, the reduction of dead weight, and freedom from concealed defects are some of the advantages which are obtainable in forgings.

Now is an excellent time to check your product for cost reductions—explore every possibility to improve performance and appearance, while reducing dead weight of component parts. Double check all parts subject to the greatest stress and strain. Check machining and finishing time schedules—forgings have been known to speed up production by 250 per cent. Rejects at the point of assembly are costly—a needless waste; forgings offer practically a 100 per cent yield of sound parts—and they respond uniformly to heat treatment. Consult a forging engineer—only a forging engineer can inform you fully regarding the many advantages obtainable with forgings.

DROP FORGING ASSOCIATION
605 HANNA BUILDING
CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1949 Edition.

Name .....

Position .....

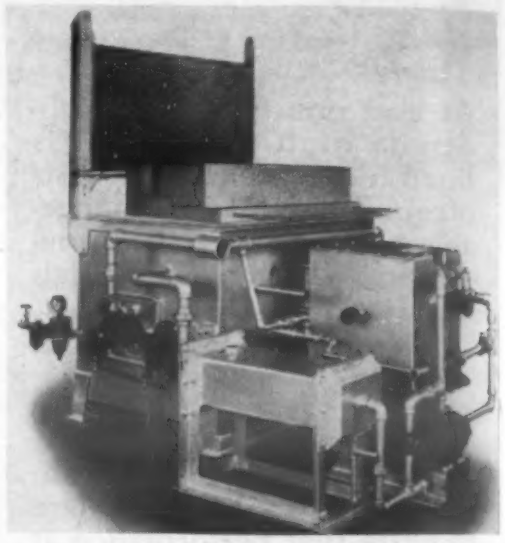
Company .....

Address .....

New Materials and Equipment

ing up the vaporized lithium for introduction to the furnace. In large furnaces, the cost of the lithium atmosphere, including the fuel required for vaporization, is estimated as low as 5c per ton of forgings.

The new furnaces are available in single and double slot types. Single slot sizes vary



The Lithium Co. has announced a vertical slot forge furnace which utilizes a lithium protective atmosphere.

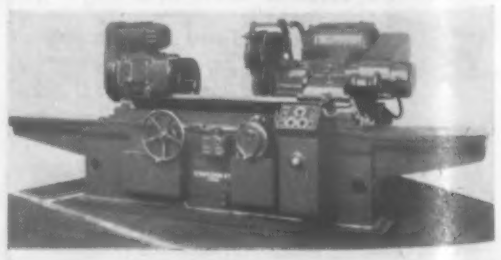
from 18 in. wide by 12 in. deep by 2 to 3 in. high to 64 in. wide by 20 in. deep by 3 to 4 in. high. Double slot furnaces are available in six slot sizes ranging from 18 in. wide by 12 in. deep by 27 in. high to 48 in. wide by 20 in. deep by 40 in. high. In both types of furnaces, the refractory tiles are adjustable to alter the working opening and slot depth for pieces of varying size or for band heating.

●

Finishing

Plain Grinding Machines

Two new Plain Grinding Machines, Filmatic 14- and 16-in. models, have been announced by *Cincinnati Milling & Grinding Machines, Inc.*, Marburg Ave., Cincin-



Shown here is the Cincinnati Filmatic 16- by 36-in. Plain Grinding Machine.

SOFT GRAY CAST IRON
Tensile 30,000 psi

"GM" MEEHANITE Metal
Tensile 60,000 psi

STEEL CASTING—0.38%C
Tensile 73,500 psi

Combines the best properties of both cast iron and steel!

The description of Meehanite metal as "Bridging the Gap" between cast iron and steel was first written just 11 years ago. Since that time Meehanite castings have been providing designers, engineers, casting users, with a superior quality material. By offering unique combinations of the better properties of both iron and steel they have met many unusual demands and specifications.

The basic facts are revealed by the microstructures of the three materials. The ability to control both the quantity, size and form of the graphite as well as the nature of the pearlitic matrix of Meehanite metal, provides the means of predetermining engineering properties so as to meet exacting specifications.

Whether you need a soft, average-property iron (30,000 psi) or a tough, high-strength material providing uniform solidity, quality and dependability, specify Meehanite metal and consult any of the foundries listed below.

Ask for the Handbook of Meehanite Metals, a 67-page engineering manual which will prove of real value to any casting user.

Take Your Casting Problems To A MEEHANITE Foundry!

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry Inc.	Providence, Rhode Island
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
The Prescott Co.	Menominee, Michigan
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

MEEHANITE®

PERSHING SQUARE BUILDING • NEW ROCHELLE, N. Y.

LOW LOSS . . . HIGH DIELECTRIC STRENGTH AT LOW COST WITH ACE HARD RUBBER

X-2-B hard rubber in this tiny, intricate tube socket gave a two-fold saving: Lower materials costs, and lower production costs with olive-brown sheets that punch cleanly, assemble neatly.

This is just one of many thousands of electrical parts for which X-2-B sheets, rods and tubes have proven best, most economical. Just look at this unparalleled combination of sheet properties:

Tensile strength	8,700 psi
Specific gravity	1.27
Distortion temperature	172° F.
Dielectric strength, v/mil, s.t.	485
Power factor, 1 KC	43%
Dielectric constant, 1 KC	4.0
Surface resistance, 74° F., 90% RH	2.5 x 10^5 megohms
Water absorption, 48 hrs., RT	0.08

Other Ace hard rubber compounds offer strength to 9,700 psi, dielectric strength to 613 v/mil, heat resistance to 300° F., water absorption as low as 0.04, with complete facilities for design, molding, extruding, machining, finishing, etc. Also Ace plastics such as Parian (polyethylene), Saran, etc.

It's a good idea to look into the 60-pg. Ace Hard Rubber and Plastics Handbook whenever you have a materials problem. Better still, phone or write our Engineering Service Department.

Send for free 60-page Ace Handbook —a gold mine of helpful data

ACE AMERICAN HARD RUBBER COMPANY
Since 1851
HARD RUBBER and PLASTICS
11 MERCER STREET • NEW YORK 13, N. Y.

New Materials and Equipment

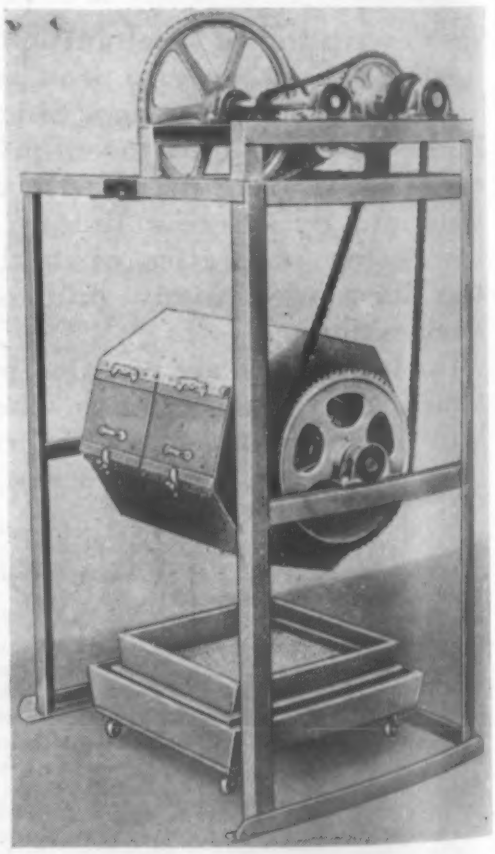
nati, Ohio, for grinding medium- to large-sized parts.

The grinding wheel spindles run on Filmatic bearings which consist of multiple segments, fixed axially but free to rock radially a slight amount. Immediately upon rotation of the spindle, wedge-shaped oil films are formed between the segments and spindle diameter. They build up to high pressures and automatically adjust themselves to variations in forces created by the grinding action.

Other important features include automatic lubrication of Filmatic bearings; variable table traverse rates between 3 and 120 in. per min.; automatic acceleration and deceleration of the table at reversal; headstock having exceptionally long bearing on the table; sheet metal telescopic way guards; and conveniently located electrical control panel.

Tumbling Machine

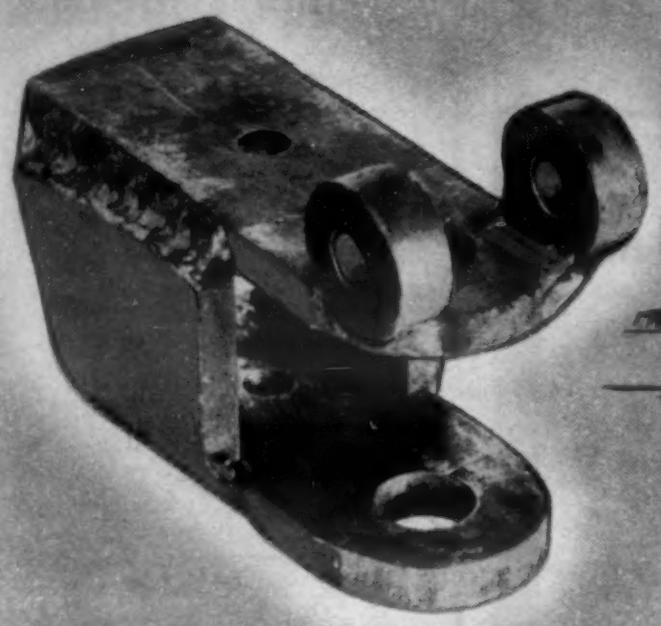
An improved tumbling machine, in which the bearings are mounted on the raised frame for positive direct support to the drive mechanism, has been announced by

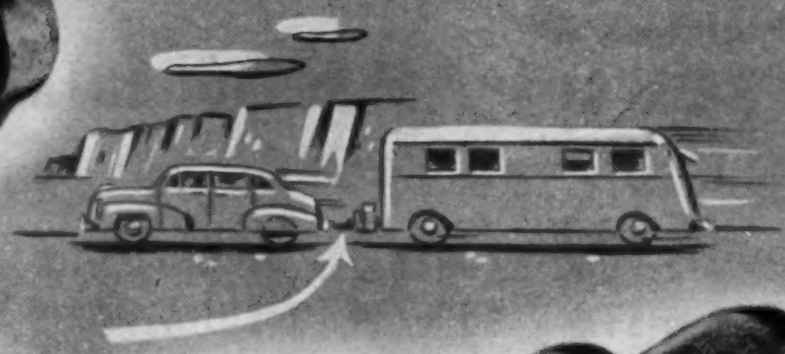


Pictured here is the latest Tumb-L-Matic model tumbling machine.

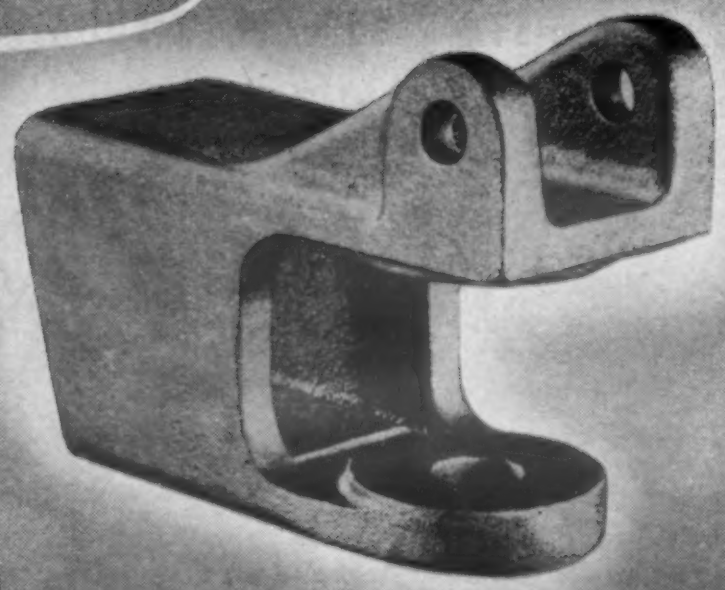
Lupomatic Industries, Inc., 4510 Bullard Ave., New York 66. More substantial construction is claimed as a result for this new Tumb-L-Matic model, designed for deburring, cutting and polishing metal parts.

PRODUCT DESIGN STUDIES • NO. 27





Fabricated TOW-BAR



Cast Steel TOW-BAR

Machine Work Cut 75%
Cost Cut Substantially
Greater Sales Appeal
with STEEL CASTINGS

The pilot model of this auto trailer tow-bar was produced as a weldment. Although the weldment proved satisfactory for experimental purposes, it failed to meet marketing requirements.

Turning to steel castings, the manufacturer obtained low *finished* cost with 75% less machine work, good appearance, and accuracy with durability . . . because the steel casting was *foundry engineered* for the job.

• • •

Conversion of *your* parts to steel castings may result in equal if not greater benefits than those given here.

Also in new and redesigned parts, your steel foundry engineer may be able to suggest ways to cut costs and weight and obtain other substantial benefits. Why not call him in for a discussion *while your product is still on the drawing board.*

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by Steel Founders' Society of America.

STEEL FOUNDERS' SOCIETY OF AMERICA
920 Midland Building Cleveland 15, Ohio

Design and Build With Steel Castings

COOPER ALLOY
NEWSCAST
PUBLISHED BY THE COOPER ALLOY FOUNDRY CO., HILLSIDE, N. J.

THERE'S GOLD IN CALIFORNIA BUT GOULD IN SENECA FALLS

PUMP PIONEERS ANNOUNCE NEW STAINLESS CENTRIFUGAL UNIT

1849 . . . the famous California Gold Rush was on! One year later Seabury S. Gould had designed and cast the world's first all metal pump at Seneca Falls, N. Y. The Gold Rush is just a memory, but Goulds Pumps, Inc., is the largest pump manufacturing plant in the world.

Their new stainless steel centrifugal pump, Fig. 3705, was created to provide economical handling of a variety of acid and alkaline liquors. Rugged in performance and economical in operation, it was designed to meet the corrosive conditions present in the chemical, process and allied industries. For economy, the fluid end, which is specified in stainless steel, is mounted on cast iron supports. This allows selection of the most suitable high alloy material for all parts in contact with the liquid, while permitting the use of less expensive materials where high corrosion or abrasion resistance is not required. From the viewpoint of maintenance, both suction and discharge connections are located in the stainless casing. Removal of the casing cover permits the pump interior to be inspected or cleaned without disturbing pipe connections.

Built to handle up to 720 gallons per minute with heads up to 200 feet, depending upon capacity, these new centrifugal pumps are ideal for the rigid requirements encountered in the process industries. To provide maximum service under the most exacting conditions, Goulds engineers have specified Cooper Alloy stainless castings for the major components in contact with corrosive media. Quality castings plus top design engineering assure long trouble-free service.

AVAILABLE UPON REQUEST technical data chart giving analyses, comparative alloy designations, properties, and applications of cast stainless, nickel and monel.

The COOPER ALLOY Foundry Co.....leading producer of Stainless Steel VALVES · FITTINGS · CASTINGS

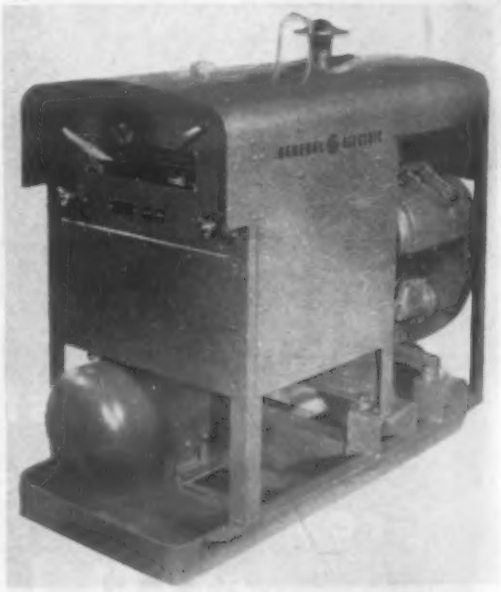
New Materials and Equipment

Welding and Joining

Arc Welder Line

General Electric's Welding Div. has announced a new line of lightweight mobile engine-driven d.c. arc welders known as the WD-40 Series.

One of the five in the WD-40 Series is a general-purpose, heavy-duty welder, WD-42AGW. It is designed for welding jobs, such as pipeline operations, which require portability. The machine weighs 1050 lb. and has a rated output of 200 amp. at 40 v. It is driven by a 31-hp. Wisconsin VP-4 air-cooled engine with a magneto ignition.

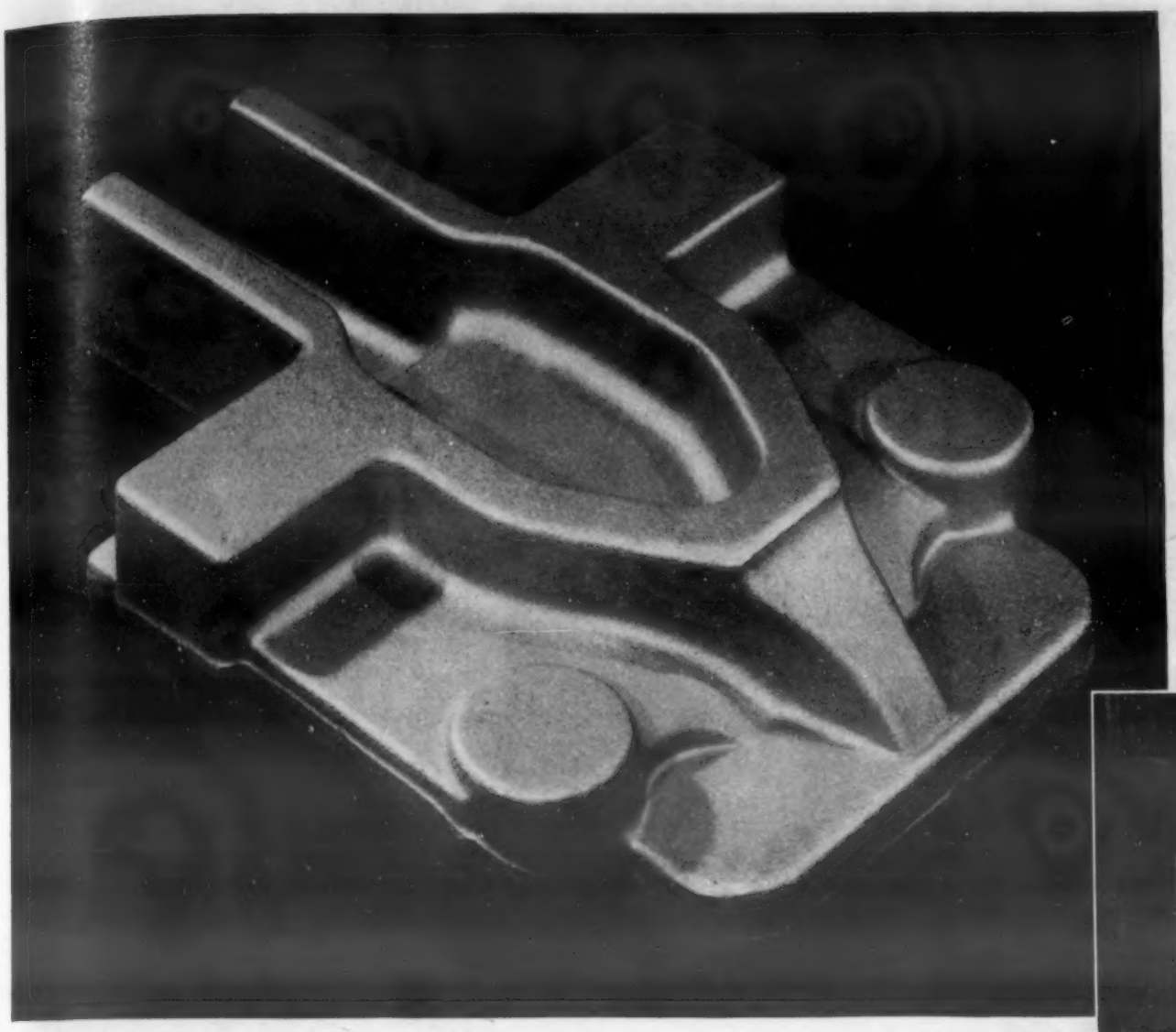


This 200-amp. 40-v. d.c. arc welder, Model 6WD42AGW, is one of a new General Electric engine-generator line.

A manually operated slow-down control economizes on fuel by slowing the engine to idling speed when not holding an arc. This welder is also available with a four-cylinder, liquid-cooled Hercules engine drive.

Other welders, also available in the liquid-cooled gasoline-engine drives, are the WD-43AG and WD-44AG; they are powered by a 6-cylinder, 63-hp. Chrysler industrial engine. The WD-43AG is frequently used in the construction industry for welding beams and girders and for general maintenance work. The machine weighs 1725 lb. and is rated at 300 amp. at 40 v. The 400-amp. model, WD-44AG, weighs 1775 lb. and has a welding range of 80 to 500 amp. Both models are equipped with belt-driven governors to prevent overspeeding of the engine and an automatic slow-down device to save gas.

The WD-40 series has four welders in the diesel-drive line. The two 300-amp.



A 125-lb heavy-duty axle part recently forged at Bethlehem. Other typical Bethlehem drop forgings include parts for the automotive, electrical, and aviation industries; for oil-field equipment; for tractors, conveyors, valves, pneumatic tools, compressors, flexible couplings, etc.

Ready, Willing and Able

to handle your drop-forgings business

Bethlehem offers a complete and highly-diversified drop-forgings service — one that starts with the making of the steel and carries through all the operations of die-sinking, forging, treating and inspection.

Our closed-die forging equipment includes steam and board drop hammers, 1500 to 8000 lb; mechanical presses to 2000 tons; upsetters 9 in. and smaller. Because of this variety, Bethlehem can forge with closed dies innumerable different designs in weights ranging from 1½ to 200 lb.

We have the men, the plant, the steel, the machines . . . plus many years of solid experience. Try us. We'll do a good job for you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

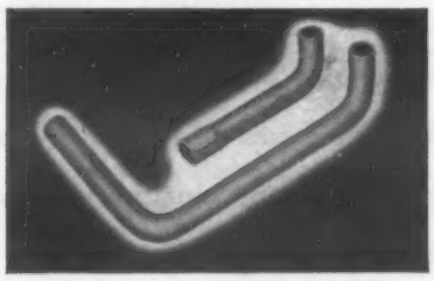
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

This Teat Cup Hood is part of a milking-machine washer. Tyer makes parts for this industry that require odorless, non-toxic compounds; resistant to animal fats, washing solutions and detergents. For each of these purposes Tyer has developed compounds exactly engineered

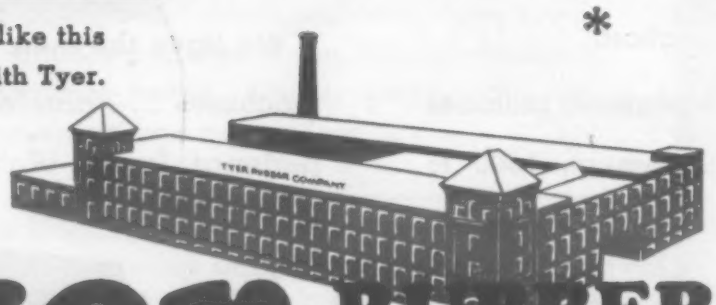
For 92 years Tyer has been doing remarkable things with rubber. Tyer originated WHITE RUBBER and ELASTIC WEBBING. Tyer's war products ranged from giant pontons to tiny earplugs made to a tolerance of one thousandth of an inch. Today Tyer leads in SERVICE to INDUSTRY. Many of the country's finest products have vital rubber parts made by Tyer. These famous manufacturers know that Tyer does unusual things with rubber.



Formed tubing like this is a specialty with Tyer.

If there is a rubber part in your product (old, new or proposed) Tyer technicians will give you the utmost cooperation in putting all Tyer's 92 years of experience at your service. Ask the Tyer representative. Write to us in Andover or to the nearest branch.

*



Tyer RUBBER COMPANY

* **ANDOVER, MASSACHUSETTS**

159 Duane St., **NEW YORK** 189 W. Madison St., **CHICAGO** 3-252 Gen. Motors Bldg., **DETROIT**

New Materials and Equipment

models, WD-43ADGM (General Motors diesel engine) and WD-43ADC (Caterpillar), weigh 2350 and 3350 lb., respectively, and have a welding range of 60 to 375 amp. In the 400-amp. line, WD-44ADGM and WD-44ADC have a welding range of 80 to 500 amp. All diesel engines are equipped with batteries, generators, electric starters and preheaters to facilitate operation in subnormal temperatures. Further information can be obtained from General Electric Co., Schenectady 5, N. Y.

Blind Rivet

Cherry Rivet Co., Winston St. at Wall, Los Angeles 13, Calif., has announced the addition of the Drive Pin Blind Rivet series, a hammer-driven rivet, to its standard line of mechanical blind rivets.

Installed with an ordinary hammer, the Drive Pin Rivet is said to make possible good joints in much less time than is required for self-tapping screws, solid rivets or nuts and bolts. Specific advantages of this rivet include (1) convenience of working from one side of the job, (2) simplicity of installation that makes skilled labor unnecessary, (3) broad material thickness tolerance, and (4) elimination of special tools.

This particular series has been designed to meet average strength requirements and is suitable for fastening relatively thin metal sheets to heavier sections or heavier gage sheets to one another.

●

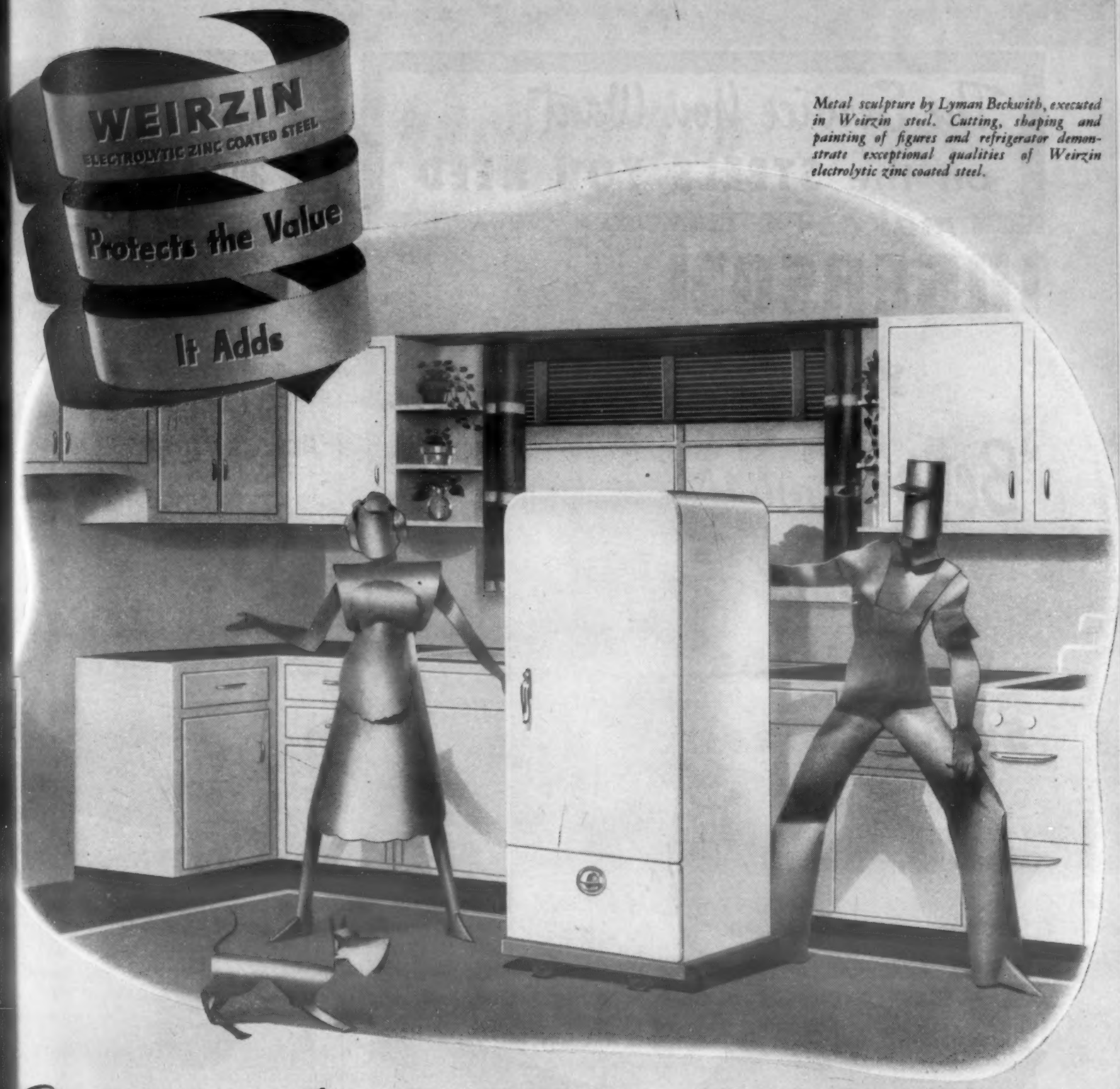
Cutting and Forming

Press Brake Gage

An automatic, self-indexing rotary type gage for press brakes has been introduced by *General Gas Light Co.*, 202 N. Park St., Kalamazoo, Mich. Ease of setting, accurate gaging, and saving in materials handling time are claimed for the gage which is to be called the Humphrey Rodex gage.

The instrument consists of a rack and gear assembly which automatically rotates adjustable gage stops into position and holds them securely until the bend has been made. The rack, which is attached directly to the punch, engages the gears and, on the upstroke, brings the stops to the position required for the bend. The rack can be disengaged from the gears to permit the use of the gage as a single-stop gage.

The gage stops have been located in the



Metal sculpture by Lyman Beckwith, executed in Weirzin steel. Cutting, shaping and painting of figures and refrigerator demonstrate exceptional qualities of Weirzin electrolytic zinc coated steel.

Special recipe for a Dream Kitchen—

The home-owner whose kitchen appliances are made of Weirzin is fortunate indeed . . . for products made of this superior electrolytic zinc coated steel are extra good to start with and *stay* extra good.

Why? Well, for one thing, Weirzin's superior strength and workability make it easy and economical for appliance manufacturers to turn out flawless products. Also, Weirzin is highly corrosion-resistant in itself; in fact, it does not require a protective finish to preserve it.

And when used in appliances that are to be beautified in gleaming white or color, Weirzin has the happy faculty of taking enamel, lacquer, or paint, and holding on to it for keeps. So, the beauty of your appliance is bound to last—because the finish *clings* to Weirzin.

Leading manufacturers of appliances, metal wall tile, storm sash, kitchen cabinets, and other steel products, are using Weirzin because it facilitates production and creates customer satisfaction. Weirzin protects the value it adds to make good products better.

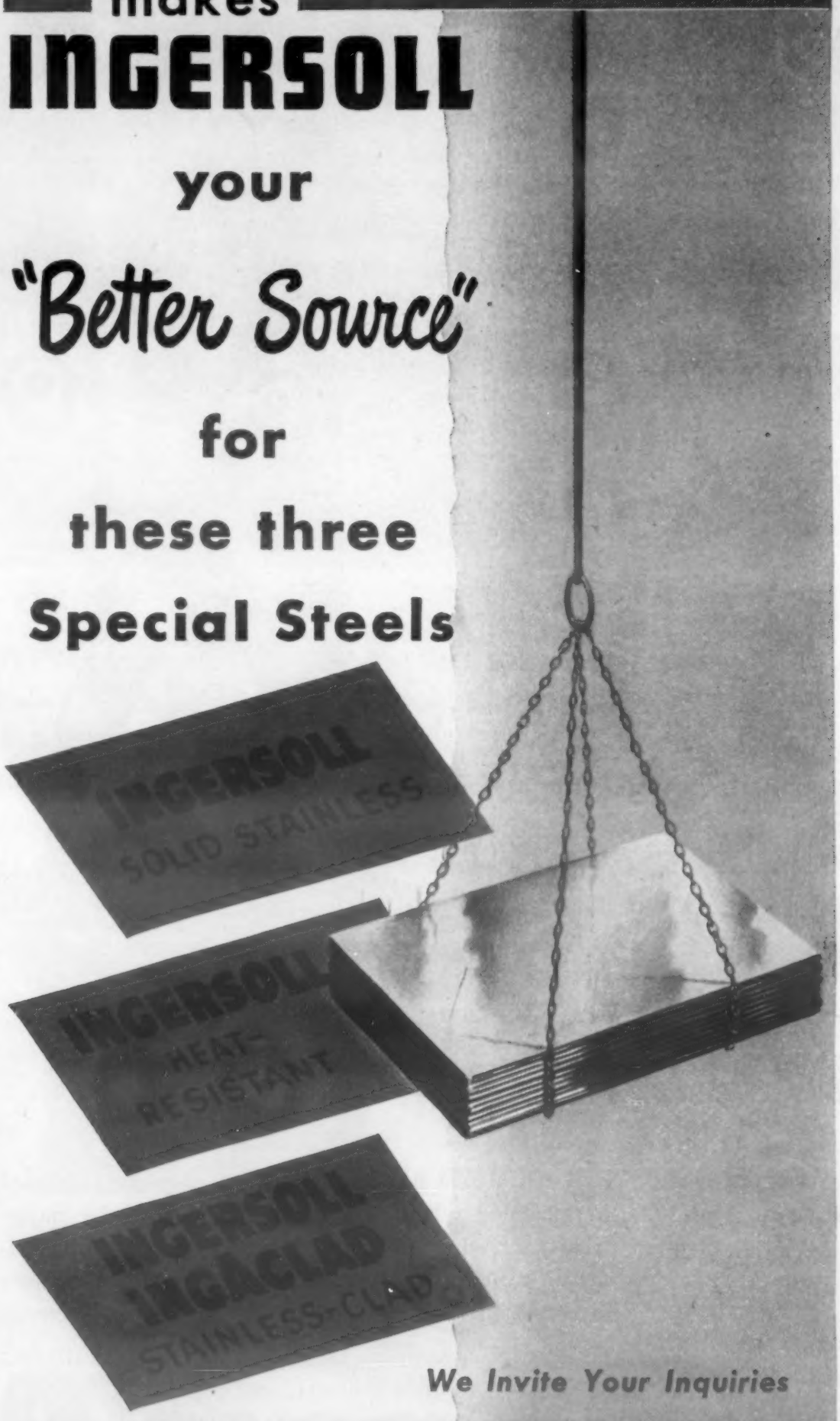
WEIRTON STEEL CO.

WEIRTON, W. VA., Sales Offices in Principal Cities
Division of NATIONAL STEEL CORPORATION, Executive Offices, Pittsburgh, Pennsylvania

WEIRTON STEEL COMPANY

Weirzin Electrolytic Zinc Coated Sheets and Strip • Weirite Tin Plate and Tin Mill Products • Hot-Rolled and Cold-Rolled Sheets and Strip • High-Carbon Strip Cold-Rolled Spring Steel

The Service You Want
on the **STEELS YOU NEED**
makes
INGERSOLL
your
"Better Source"
for
these three
Special Steels



We Invite Your Inquiries

INGERSOLL STEEL DIVISION
BORG-WARNER CORPORATION
310 South Michigan Avenue, Chicago 4, Illinois
Plants: Chicago, Illinois; New Castle, Indiana; Kalamazoo, Michigan

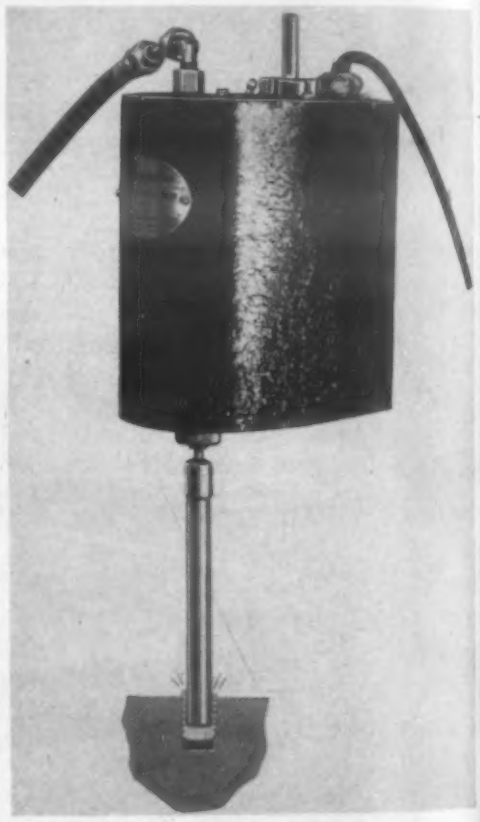
ENGINEERING B-W PRODUCTION

New Materials and Equipment

rotating member so as to meet practically any bending requirement; the gage is claimed to make possible the producing of as many as four different bends in a piece of metal before it leaves the operator's hands.

Metal Disintegrator

A metal disintegrator, intended chiefly for removing taps, drills, etc. from holes without distorting the threads, and for cutting shaped holes in dies, is being marketed



Shown here is the new metal disintegrator available from Clinton Machine Co.

by the *Metalmaster Div.* of *Clinton Machine Co.*, Clinton, Mich. Labeled the 1950 Thomas Metalmaster Junior, the device removes broken taps from 0.080 to 1 in. and can be attached and operated on any standard drill press.

Shear Line

A new, simple shear line has been developed by *E. W. Bliss Co.*, 1420 Hastings St., Toledo 7, Ohio, to flatten coil stock and cut it to any length at about 300 ft. per min. It is designed for moderate production in steel, brass and copper mills, warehouses and fabricating plants.

The complete line includes coil stop, payoff reel, roller leveller, looping table, upcut shear, gage table and automatic gage unit, oiling unit, pinch rolls and sheet piler.

Hot news on hard-facing!

Actual reports from users of Stoody Alloys

Published quarterly by the
STOODY COMPANY

EVER WONDER how the other fellow solved his ar problem? Ever wish you had reference source of field-proven rd-facing applications? You can ve this and more . . . for every ue of Fusion Facts is packed with ormation . . . day to day wear problems and their solution h Stoody Alloys . . . field reports straight from the men who doing the job.

Over twenty years ago "Fusion Facts" was born when ody Company first published interesting hard-facing experi-ces of its customers. These ideas proved so helpful to others t today FUSION FACTS has a circulation equal to many trade rnals. It is the hard-facing Bible in many trade schools and lleges!

e want you to benefit by Fusion Facts too

But before your name can be added to our mailing list, u must qualify. You don't have to be a company president; even a V. P. But we do want readers who have a definite d and use for our magazine. So, to get your quarterly copy FUSION FACTS, simply return the enclosed coupon. There is charge . . . FUSION FACTS will start arriving with the next ue—ready to go to work, ready to stimulate new ideas on ing diversified wear problems.

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MICROCASTING

ELIMINATES SPECIAL TOOLING

ESTIMATED SAVING 75%

Microcast parts are smooth, uniform, sound as cast (actual size).

Quantity Production of Intricate Parts from High-Melting-Point Alloys

BY using the MICROCAST PROCESS to produce this alloy steel rocker arm for packaging machinery, the manufacturer saved an estimated 75% over conventional production methods. Microcast can effect remarkable savings by eliminating the necessity of forging dies, special tooling, drilling, and similar operations.

Metallurgists and design engineers will find that with Microcast there are many opportunities for product improvement. Because Microcastings, as cast, are of sound structure, dimensionally uniform, and to such close tolerances that virtually no machining is required, small components of intricate shape can now be specified in the extremely hard, non-machineable, and non-forgeable alloys such as stainless steel, tool steels, Stellite, and others. Write today for complete information.

MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
224 E. 39th St., New York 16, N. Y.,
or 715 E. 69th Place, Chicago 37, Ill.

MICROCAST PRECISION CASTINGS PROCESS

MICROCAST

FREE BOOKLET
Send for 16-page Microcast Booklet. Contains many "case histories" and step-by-step explanation of Microcast Process.

New Materials and Equipment

Drawing Compound

Northwest Chemical Co., 9310 Roselaw Ave., Detroit 4, Mich., has announced drawing compound, Fluid-Film, which said to maintain its inherent physical prop erties during repeated stamping of ferrou and nonferrous alloys.

The complex, semi-plastic composition has high film strength and is claimed no to separate even under intense stresses. Th stability of the compound is such that th electrical properties of the molecules at the interface between the lubricant and the metal surfaces remain constant during the drawing operation. The compound can be stored indefinitely, and the organic mole cules also resist chemical and physical de terioration from atmospheric exposure. No heavy residue or surface stains result from use of this compound.

Fluid-Film, made ready-to-use in mo

This piece is No. 10,000 of a single-ope tion stamping in which Fluid-Film was use

instances, is available in non-pigmented form only, but is said to handle even ex treme drawing operations. It can be applied by brush, spray, roll or dip; precleaning is unnecessary as it can be applied over mi oil surface. It air dries within a few min utes and can be force-dried in seconds. Some forms of Fluid-Film can be removed with hot water, but all forms can be removed with an alkaline cleaner.

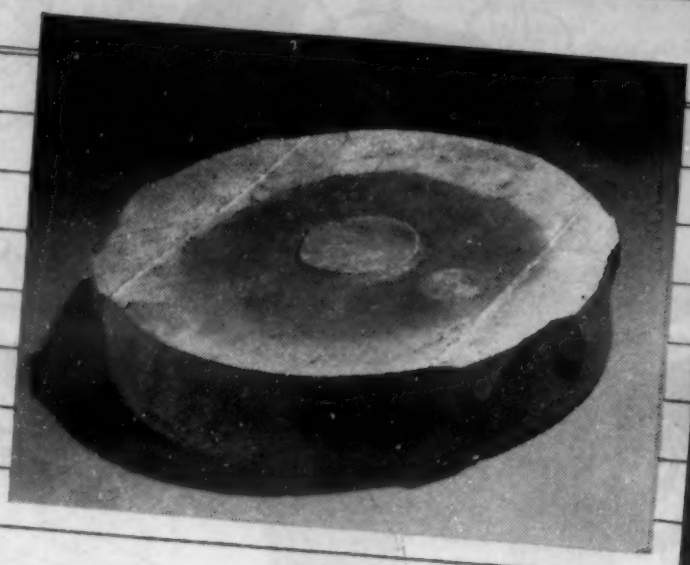
Testing and Inspection

Coating Thickness Gage

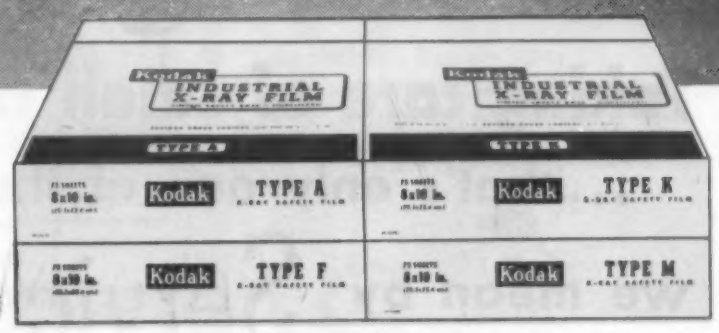
A special-purpose Magne-Gage for meas uring the thickness of nickel coatings ranging from 0.001 to 0.0045 in., on iron and steel by magnetic means has been an nounced by *American Instrument Co., Inc.*

What's the right X-Ray film?

Product:
Cast part for vital aircraft pump
Material:
Aluminum, 2¼" thick, 11¼" diameter
Equipment:
150kv x-ray unit



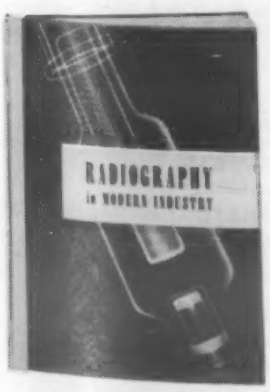
ANSWER:



KODAK INDUSTRIAL X-RAY FILM, TYPE A

With time, money and safety at stake, radiography was used to check this important casting for defects. With moderate kilovoltage to work with, and with aluminum as the material, the radiographer selected Kodak Industrial X-ray Film, Type A.

For with light alloys, this film has enough speed to keep exposures reasonably short even at low voltages. Its high contrast and fine graininess also permit taking full advantage of high kilovoltage machines in detecting irregularities in thick dense materials.



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get your copy from your local x-ray dealer—price, $3.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. They also provide the means to check welds efficiently and thus extend the use of the welding process.

Type A—has high contrast with time-saving speed for study of light alloys at low voltage and for examining heavy parts at 1000kv. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, under direct exposure or with lead-foil screens. It has extra-fine grain and, though speed is less than in Type A, it is adequate for light alloys at average kilovoltage and for much million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays, exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.

EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N. Y.

Radiography...

another important function of photography

Kodak
TRADE-MARK

"Taking care of small customers"

...that's only one of the things

we mean by Service Plus!

● Many of our customers are probably classified as "small business." We were delighted to find, through a recent survey, that the men in charge of these so-called small companies are well satisfied with the service they get from United States Steel Supply Company. More than one said, "You take care of the little fellow." We know every order, large or small, is important to the man who places it. And we do our best to meet his requirements in handling it. If you need steel, from stock or in special sizes, forms or specifications, call us. Your order is as important to us as it is to you.

Service Plus is our promise of *extra* attention to your needs. It includes prompt delivery, large stocks of both standard and special sizes, and an unrivaled reputation for courteous attention to your every requirement. *Service Plus* means "You tell us and we'll do it if it's humanly possible."

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TULSA · YOUNGSTOWN
Headquarters Offices: 208 S. La Salle St.—Chicago 4, Ill.

UNITED STATES STEEL

New Materials and Equipment

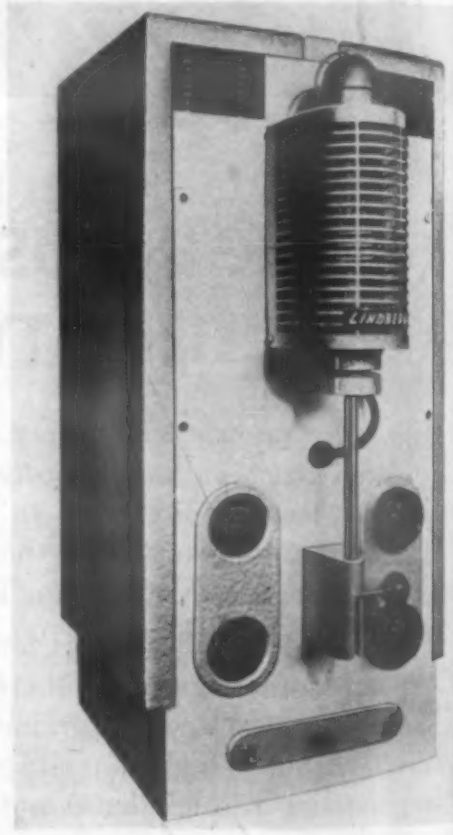
8030 Georgia Ave., Silver Spring, Md. With this gage the measurement can be performed without injuring the coating or base metal.

The thickness range on this instrument is beyond that of the standard Magne-Gage (0 to 0.002 in.), and cannot be supplied on gages having other calibrations.

Carbon and Sulfur Analysis

Carbon and sulfur analysis of iron and steel is accomplished by direct combustion at temperatures over 3000 F in a new unit available from *Lindberg Engineering Co.*, 2444 W. Hubbard St., Chicago 12, Ill.

High frequency induction heating is used to bring the iron or steel sample to the ig-



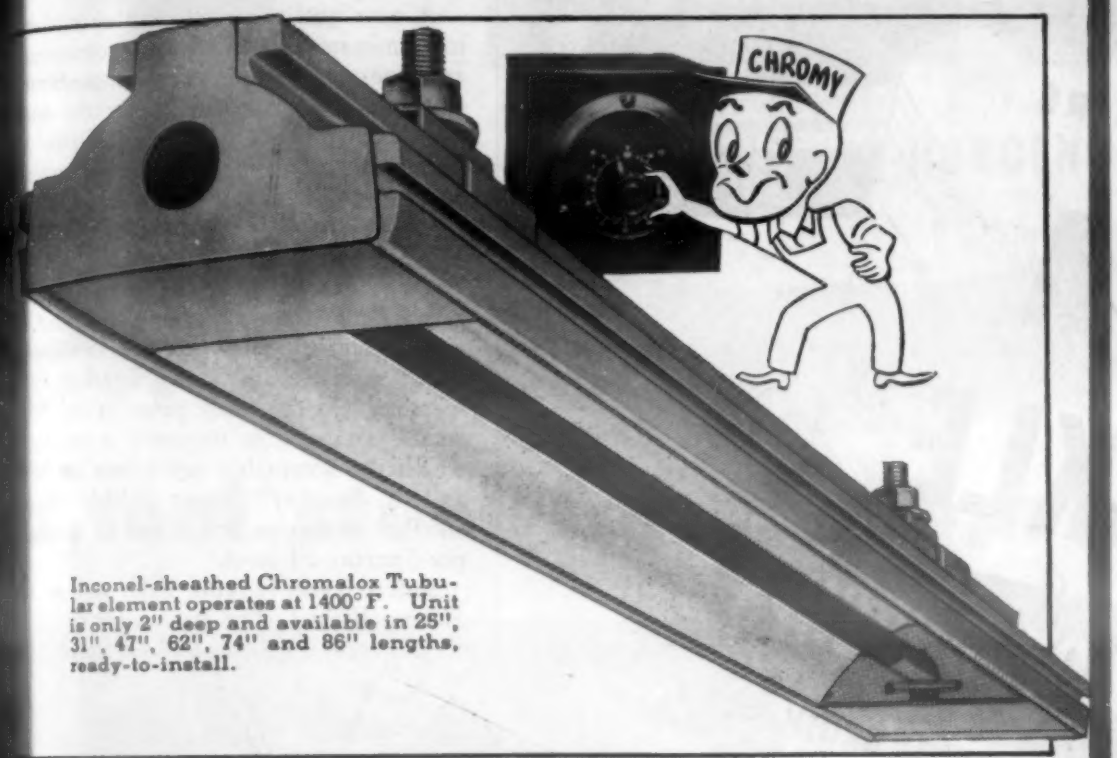
This laboratory high frequency combustion unit is made by Lindberg Engineering Co. for carbon and sulfur analysis.

nition temperature almost instantly. The Lindberg unit requires a "warm-up" period of only 57 sec., compared to 2 to 3 hr. for resistance element furnaces. Although the sample is melted in 2 to 3 sec., adjacent parts such as crucible and tube are heated only by radiation or conduction from the relatively small mass of the charge.

The unit, known as Type LI-500A, is adaptable with equal efficiency to either standard gravimetric procedures or volumetric determinations. Minimized heating of the gas samples plus a greater number of complete gas changes in the short combustion tube make it particularly adaptable to accurate volumetric type determinations.

NOW **Dial** YOUR

INFRARED HEAT



Inconel-sheathed Chromalox Tubular element operates at 1400° F. Unit is only 2" deep and available in 25", 31", 47", 62", 74" and 86" lengths, ready-to-install.

WITH **CHROMALOX** ALL-METAL *Electric*

Radiant Heaters

Uniform, exact heat when you want it is yours at the turn of a dial when you use CHROMALOX Electric Radiant Heaters as your heat source for infrared drying, preheating, baking, curing, dehydrating and similar applications.

Quickly and easily installed CHROMALOX Radiant Heaters give uniform heat without hot spots; operate efficiently in low and high ambient temperatures; provide glareless radiation in wave lengths absorbed more efficiently by all colors, textures and surfaces. All-metal construction enables units to withstand shock, vibration, dust, moisture; and eliminates hazards of contamination.

Write today for details on how flexible and dependable CHROMALOX Radiant Heaters can save time, materials and money in your plant.

DIALED INFRARED HEAT WILL GIVE YOU ALL THESE ADVANTAGES . . .

EXACT HEAT CONTROL
Finger-tip control at the turn of the input controller knob assures consistent, exact operating temperatures every time!

PRECISE DUPLICATION
It's easy to duplicate required working temperatures day-in and day-out without guesswork by setting the input controller dial to the logged temperature point.

QUICK CHANGE-OVERS
Within a few minutes after the input controller is reset, you have a new heat to meet changed temperature requirements.

MULTI-PURPOSE or ZONED OVENS
Various zones of heat are possible within the same oven by setting up separate controls for each bank of units. Then each bank can be individually controlled by its own dial.

CHROMALOX } *Electric Heat for Modern Industry*

FACTS ABOUT APPLICATIONS USING CHROMALOX RADIANT HEATERS

Many plants, faced with increasing production costs, have substantially cut working time and costs by using Chromalox Electric Radiant Heaters. If you use heat in your plant for processing, perhaps, you too can benefit by changing to Chromalox Electric Radiant Heat. Look over the typical applications below . . . then send for the full story about this modern heat source.

Application Report 101:
LESS FLOOR SPACE—SAFER OPERATING CONDITIONS are features of a Radiant Heater installation that also provides faster, continuous production for forming soft balls in heated metal molds.

Application Report 102:
SPEEDIER DRYING, NO HOT SPOTS with Chromalox Radiant Heaters result in complete and uniform drying of plastic powders in 10-15 minutes, compared with half-hour with previous heating method.

Application Report 104:
NO DISCOMFORT FOR OPERATOR of punch press while punching holes in plastic strip material. Radiant Heater is used to maintain proper temperature in strips between preheating oven and press.

Application Report 105:
OPERATING IN HIGH AMBIENT TEMPERATURES, Chromalox Radiant Heaters provide a more efficient method for more uniformly knitting asphalt to battery cases. Variable control adjusts heat to battery heights.

Application Report 109:
NO GLARE TO ANNOY PERSONNEL is one feature of Chromalox Radiant Heaters used to dry a cement seal in base of television tubes. Heaters operate on an open conveyor.

Get the complete RADIANT HEATER Application Reports!

Yes . . . send me full details on Chromalox Radiant Heaters.

Name_____

Company_____

Street_____

City_____ Zone_____

State_____

Mail to: EDWIN L. WIEGAND COMPANY
7523 THOMAS BOULEVARD
PITTSBURGH 8, PA.

IC-46

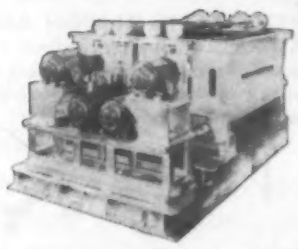
WHEN YOU'RE

"IN A PICKLE"

FULLERGRIPT BRUSHES

INSTALLED IN ROCKWELL BRUSH BOX

SCRUB CLEAN



Typical of the equipment designed and built for the metal working and metal finishing industries by the W. S. Rockwell Company of Fairfield, Connecticut is the Rockwell Brush Box, used in connection with a continuous strip anneal and pickle line to produce a clean, bright finish on brass strip. Into this machine Rockwell engineers have built four power-driven Fullergript brushes. The brush material is stainless steel wire anchored in a stainless steel backing strip to withstand the corrosive effect of the pickling or cleaning solution. The brush assemblies are mounted on cone type stainless steel self-centering couples for quick and easy removal of the brushes. The same set-up can be used for dry brushing metals that have a very light film of dirt or very light oxide not requiring a pickle.

Fullergript power brushes offer similar production economies in a wide variety of industries. It will pay you to investigate the possibilities of Fullergript for your own plant. Simply write to:

THE FULLER BRUSH COMPANY

INDUSTRIAL DIVISION, 3636 MAIN ST., HARTFORD 2, CONN.

New Materials and Equipment

Quality Control

A new quality control indicator, claim to eliminate time-consuming computatio and, consequently, significant manufacturi losses, is being marketed by the *Spec Products Div.* of *General Electric C* Schenectady 5, N. Y. The principle operation of this device is described el where in this issue of MATERIALS & MET ODS (p. 46).

Two units comprise the basic equipme a "totalizer" counts the units inspected, a a "characteristic analyzer" counts the rej for a given characteristic checked by i spectors. On the front panel of the cha teristic analyzer is mounted a selector which the acceptable reject rate can be s and a "quality" meter which indica whether rejections are above or below t pre-determined level.

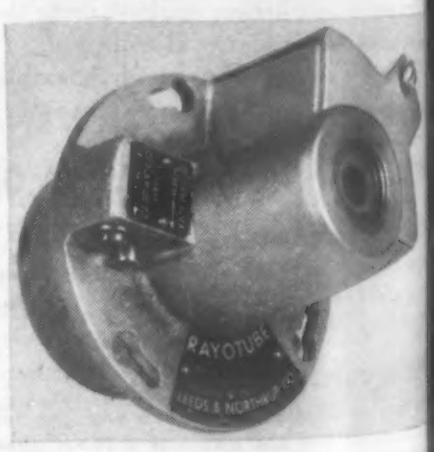
Reject levels ranging from zero to 10 can be checked. The equipment can be r on either 110-v., 60-cycle a.c. or on 110 d.c.

●

Temperature Indicatin

Radiation Pyrometer

A new Rayotube, built to work with Micromax and Speedomax Rayotube inst ments, has been announced by *Leeds Northrup Co.*, 4934 Stenton Ave., Ph delphia 44, Pa. The detector is desig



The new Rayotube features a quick-sighti optical system and hermetically sealed c struction.

for easy operation where operating c ditions are severe, such as slab furna soaking pits, open-hearths and ceramic ki

A quick-sighting optical system all the user to select the desired target ex then check the sharply-defined area wh

A-H5

(5 PCT CHROME AIR-HARDENING)

Economical, Easy Machining

a tool steel for high-production jobs

A-H5 is the backbone of this high-production die which blanks and punches sheet steel of 0.180-in. thickness. A-H5 assures long production between grinds, holds a durable cutting edge, and has high resistance to distortion in heat-treatment.

And that's not all. A-H5 provides the greater safety of air-hardening; and it wears longer and has better distortion-resistance than low-alloy, oil-hardening grades. A-H5 has deep-hardening properties in large sections, combined with shock-resistance equal to that of carbon tool steels. And with all these advantages, it's still easy to machine—it anneals to less than 212 Brinell.

A-H5 is an economical grade, because it's ideal for many tools and dies that would ordinarily call for high-carbon, high-chrome steel, such as Lehigh H. Demand for A-H5 is growing fast, for it has the high wear-resistance and durable cutting edges for high-production jobs.

Give A-H5 a fair trial and you'll find your toolroom can't get along without it.

Wide ranges of sizes for prompt delivery

Large stocks of A-H5 are available for quick delivery from Bethlehem tool-steel distributors everywhere.

HEAT-TREATMENT OF A-H5

Typical Analysis:	C	Mn	Cr	Mo	V
	1.00	0.60	5.25	1.10	0.25

Annealing: Pack, heat to 1650 F, slow furnace-cool, Brinell 212 max

Preheating: 1200 to 1250 F, prior to hardening

Hardening: 1775 F, air-quench

Tempering: 350 to 400 F, Rockwell C 60 to 62

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation

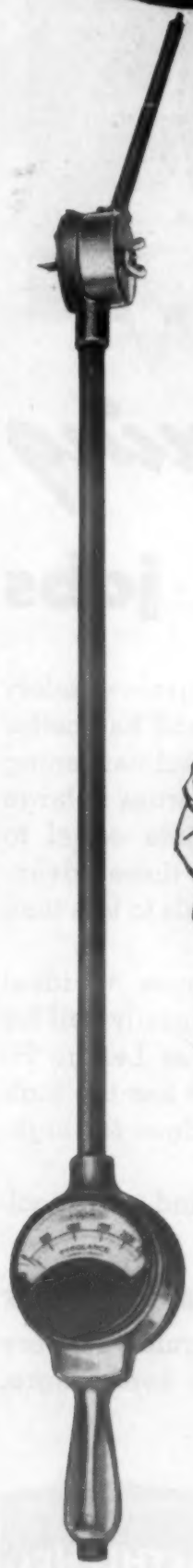
Export Distributor:
Bethlehem Steel Export Corporation

BETHLEHEM STEEL

SUPERSONIC TESTED

Bethlehem Tool Steel

Pyro Lance!



for accurate measurement of heat of MOLTEN METALS

For quick, accurate temperature readings of molten metals anywhere, rely on the Alnor Pyro Lance. Portable, handy to use, the Pyro Lance has a protected thermocouple, with adjustable angle head, mounted in the lance tip. It takes temperature below the surface—unaffected by dross or other conditions. Here's an easily handled instrument to help control quality. For complete information and prices on this valuable instrument, write for Bulletin No. 1724-D. Illinois Testing Laboratories, Inc., Room 522, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

New Materials and Equipment

the Rayotube sees. The hermetically sealed construction at lens, window and leadwires keeps out dust and gases. As the new Rayotube fits all existing Rayotube mountings, it offers low cost replacement.

The unit requires no protection against high ambient temperatures unless its housing temperature exceeds 350 F; below that point, any previously installed water- or air-cooling can be turned off or disconnected.

Indicating Pyrometers

Two new sizes of indicating pyrometers in the Simplytrol line have been announced by *Assembly Products, Inc.*, Chagrin Falls,

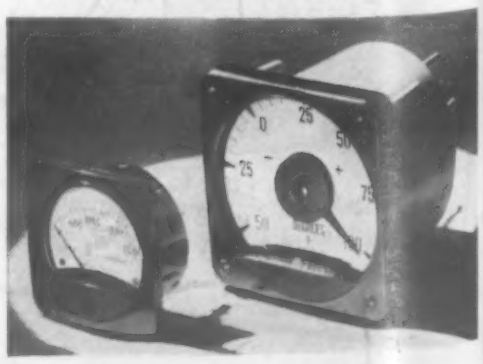
From left to right are shown Models 451, 351 and 261. The two outside models are new.

Ohio. As a result, the eight ranges, covering temperatures from −75 to 3000 F, available on Simplytrol indicators, are now offered in three standard-size instruments.

Temperature Indicators

Cold-end compensated thermocouple thermometers for measuring temperatures up to 3000 F and resistance thermometers for use up to 300 F are included in a new line of temperature indicators announced by *General Electric's Meter & Instrument Div.*

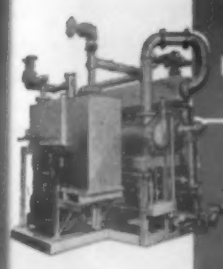
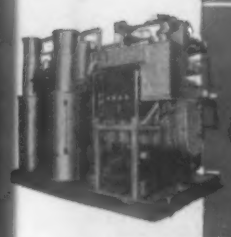
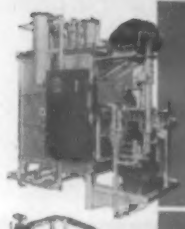
The thermocouple thermometer is available in two sizes: Type 00-71 with a 3½-in. flange, and DW-71 with a 2½-in. flange. Both types can be supplied in either



At the left is the G.E. Type DO-71 square thermocouple; at right, the G.E. Type DB-15 resistance thermometer.

'Surface' PREPARED Gas Atmospheres

...for every heat treatment of ferrous and non-ferrous metals

TYPE OF GAS	* SIZES OF AVAILABLE UNITS	METAL TO BE TREATED				
		COPPER	LOW C. STEEL UP TO 0.20 C.	MED. C. STEEL 0.20-0.60 C.	HIGH C. STEEL ABOVE 0.60	SPECIAL STEELS
 **DX GAS** (LEAN) 40° F. DEW POINT	250 TO 35,000 CU. FT. PER HOUR	BRIGHT ANNEAL	———	———	———	———
DX GAS (RICH) 40° F. DEW POINT	250 TO 35,000 CU. FT. PER HOUR	———	BRIGHT ANNEAL	UP TO 30 MIN. EXPOSURE BRIGHT ANNEAL AND CLEAN HARDEN	———	———
 **NX GAS**	1,000 TO 20,000 CU. FT. PER HOUR	BRIGHT ANNEAL	BRIGHT ANNEAL	BRIGHT ANNEAL CLEAN HARDEN	BRIGHT ANNEAL CLEAN HARDEN	———
 **RX GAS**	250 TO 3,500 CU. FT. PER HOUR	Oxygen, O_2, is the only one of the common gases which reacts with copper; consequently, the atmosphere generator may be dispensed with in the bright annealing of that metal. It is only necessary to set the furnace burners slightly rich to prevent free oxygen within the furnace.	CARBURIZE DRY CYANIDING	CARBURIZE BRIGHT ANNEAL CLEAN HARDEN CARBON RESTORATION (SKIN RECOVERY) DRY CYANIDING	BRIGHT ANNEAL CLEAN HARDEN	———
 **CHAR-MO GAS**	500 TO 1,000 CU. FT. PER HOUR		CARBURIZE	CARBURIZE BRIGHT ANNEAL CLEAN HARDEN	BRIGHT ANNEAL CLEAN HARDEN	CLEAN HARDEN TUNGSTEN MOLYBDENUM STEEL
 **AX GAS** (DISSOCIATED AMMONIA)	500 TO 4,000 CU. FT. PER HOUR		———	———	———	BRIGHT ANNEAL STAINLESS STEEL

*Where larger capacities are required multiple units can be supplied.

● Surface Combustion research in the development and use of specially prepared gas atmospheres for all heat treatments of ferrous and non-ferrous metals has made possible metallurgical results of such significance that it goes beyond the mechanical details of furnace construction.

Today, with the use of 'Surface' indirectly heated furnaces—radiant tube heating elements and muffle type units — and 'Surface' Prepared Gas Atmospheres, all metal surfaces can be treated to prevent undesirable effects or to produce surface conditions as required.

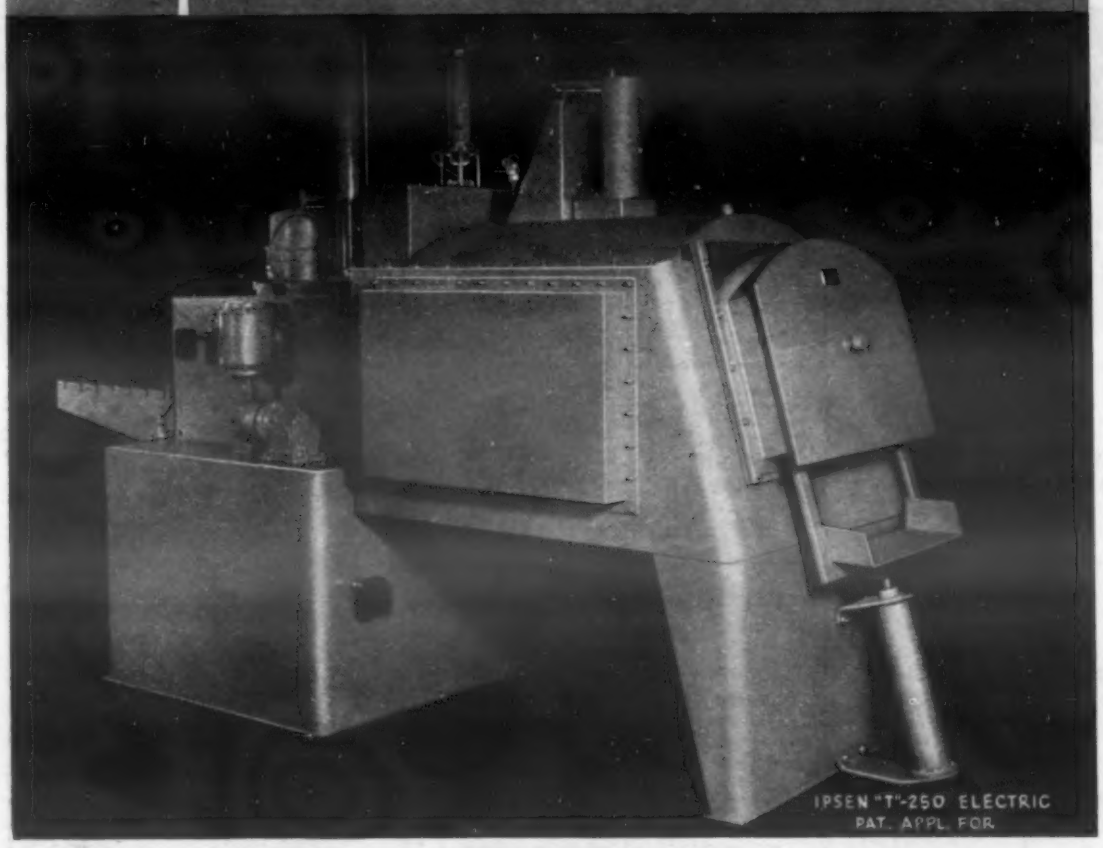
FOR PREPARED GAS ATMOSPHERE COMPOSITIONS, COSTS, AND DETAILS OF APPLICATIONS

write for booklet, "The Science of Gas Chemistry for Heat Treating" Form SC-129.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

BRIGHT CARBONITRIDE

AN EXCLUSIVE IPSEN DEVELOPMENT IN HEAT TREATMENT!



WITH THIS AUTOMATIC "T" UNIT

BRIGHT GAS CYANIDE
BRIGHT CARBURIZING
BRIGHT ANNEALING
BRIGHT HARDENING

of both large and small parts

THE AUTOMATIC Ipsen HEAT TREATING UNIT

Proved in operation for over a year!

MAIL THIS COUPON TODAY!
For New Descriptive Literature

NAME TITLE

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CITY ZONE STATE

IPSEN INDUSTRIES, INC.
520 N. MADISON STREET • ROCKFORD, ILLINOIS

New Materials and Equipment

square or round molded Textolite cases. This thermometer can be used for applications such as galvanizing vats, melting pots, industrial furnaces, infrared drying ovens, oil quenching baths, ceramic kilns, and salt baths for annealing.

The resistance thermometer is available in two standard types: DB-15 long-scale and Types DD-6 and DD-7 6-in. rectangular, surface- and flush-mounted instruments. This thermometer is designed for accurate low temperature measurements and is suitable for measuring temperatures in bearings, generator and transformer windings, refrigeration and air conditioning testing, drying operations and scientific laboratory work. Further information can be obtained from General Electric Co., Schenectady 5, N. Y.

General

Portable Radiation Detector

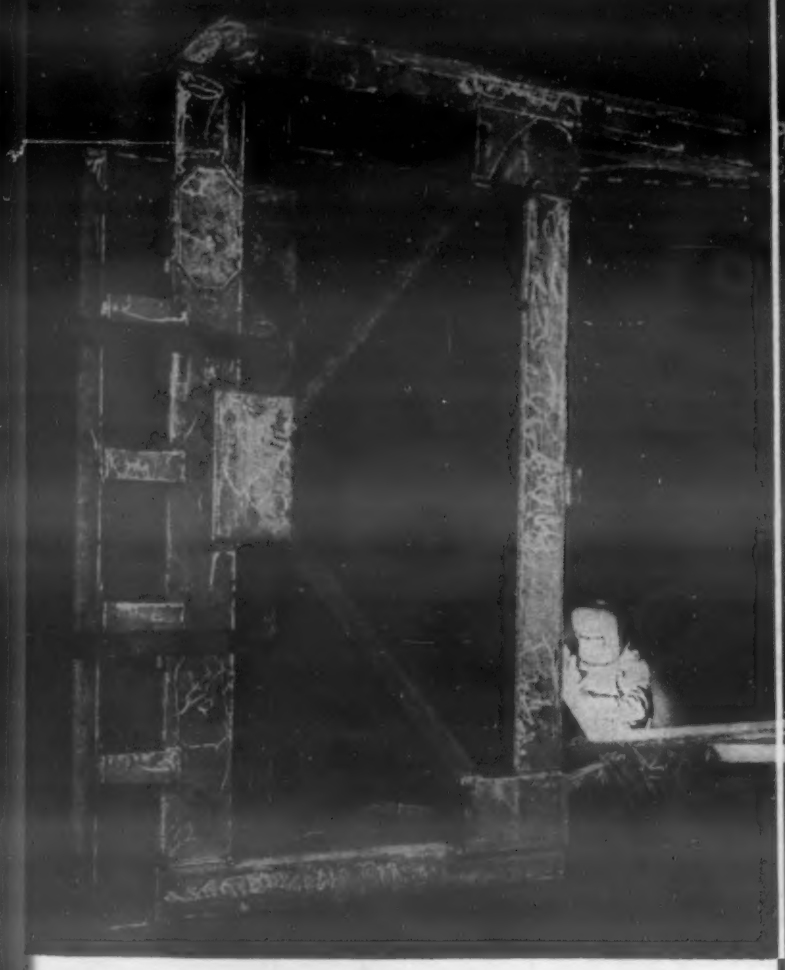
A new portable radiation detector which allows the operator to measure radioactivity from a safe distance has been announced by the *Special Products Div.* of *General Electric Co.*, Schenectady 5, N. Y. Called the long-probe Gamma Survey Meter, it was

This long-probe detector, developed by General Electric Co., permits radiation measurements from a safe distance.

developed by the company's General Engineering and Consulting Laboratory.

A detector at the tip of a 4-ft. probe converts radioactive emanations into electrical energy. The detector consists of an electronic tube and a phosphor, a material which gives off light in the presence of ra

MUREX *Speeds Welding of* EUCLID EQUIPMENT



MUREX
ELECTRODES

METAL & THERMIT CORPORATION
120 BROADWAY • NEW YORK 5, N. Y.

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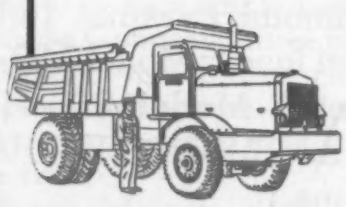
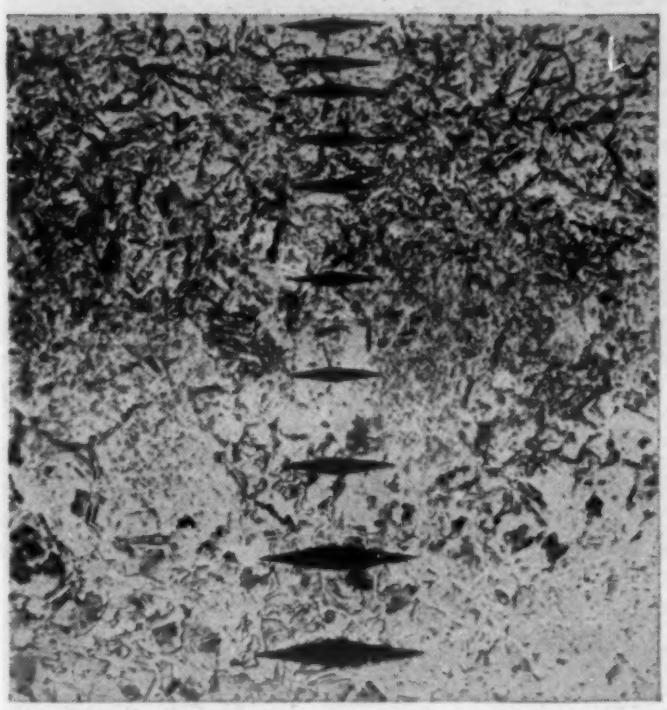
SO. SAN FRANCISCO



Fast, easy-to-use, Murex Genex electrodes speed production of welded frames for heavy duty earth moving equipment built by The Euclid Road Machinery Co. And, their nearly spatter-free operation reduces weld cleaning time to a minimum.

Many of America's leading fabricators have standardized on Murex electrodes because of their ability to provide high quality welds at low cost. Let us put you in touch with Murex performance today. Descriptive literature—yours for the asking.

TUKON



X 100 — *TUKON Test on SAE 1020 Steel—Carbonitrided. Load 500 Grams.*

3 MODELS

TUKON TESTER *for* MICROHARDNESS TESTING

FOR EVERY KIND OF MICRO-INDENTATION HARDNESS TESTING

Send for

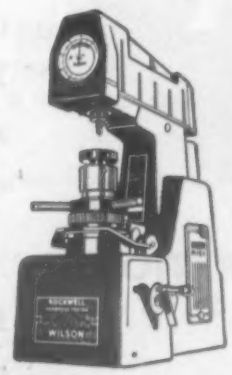
Bulletin DH-114 which contains detailed information about TUKON Hardness Testers. We will also include a copy of our booklet DH-7, which gives the experience of several users of TUKON Testers in different fields.

● The TUKON Tester may be used for testing the constituents of an alloy, thin material, small specimens, small diameter wire and for many kinds of research work—the full range of micro and macro hardness testing. All models may be used with either Knoop or 136° Diamond Pyramid Indenter. Applied loads: Model MO—1 to 1000 grams; Model FB—10 to 3600 grams; Model LR—10 to 50,000 grams.

"ROCKWELL" HARDNESS TESTER

● "ROCKWELL" Hardness Testers and "ROCKWELL" Superficial Hardness Testers were developed and are made only by Wilson for laboratory, toolroom or production line testing.

Write us about any problem you may have involving hardness testing. Our factory-trained Field Service Engineers will be glad to work with you.



WILSON MECHANICAL INSTRUMENT CO., INC.

AN ASSOCIATE COMPANY OF AMERICAN CHAIN & CABLE COMPANY, INC.

230-E PARK AVENUE, NEW YORK 17, N. Y.

ACCO

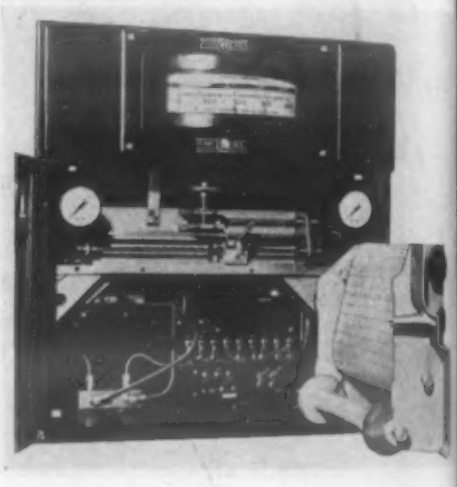
New Materials and Equipment

dioactivity. Light from the phosphor acts upon the electronic tube, which converts this light energy into electrical energy and amplifies its magnitude.

At the other end of the instrument, a dial is activated by amplified energy from the tube and registers the amount of radiation 4 ft. away. The detector is powered by 1000 v. induced from low-voltage batteries, which are enclosed in a box that can be carried over the operator's shoulder.

Strip Chart Recorder

A new air-operated strip chart recorder has been added to the line of indicating, controlling and recording instruments manufactured by *Wheelco Instruments Co.*, 847 W. Harrison St., Chicago 7, Ill.



The Wheelco "Pneumatic Capacilog" is shown as used for temperature measurements.

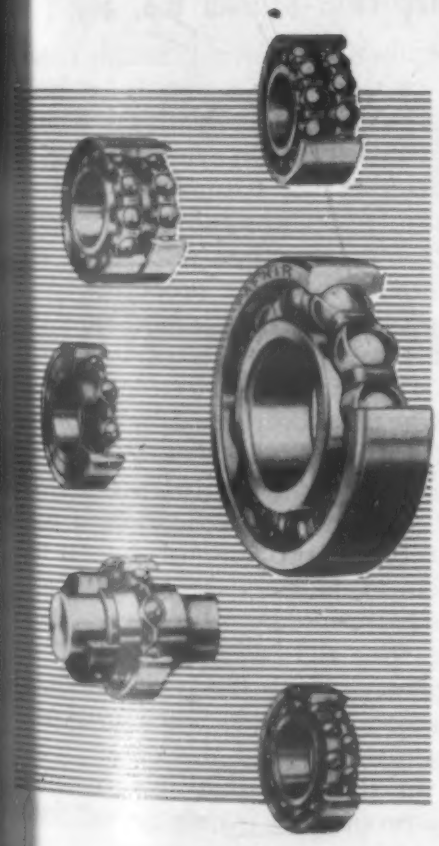
The new unit, known as "Pneumatic Capacilog," can be used to measure temperature, pressure, speed, flow, volts, etc. It is completely self-contained and has only two external air connections.

Controllers

Brown Instruments Div. of *Minneapolis-Honeywell Regulator Co.*, 2926 Fourth Ave., Minneapolis, Minn., has introduced two new instruments—one a completely redesigned millivoltmeter-indicating controller known as the Pyr-o-Vane controller and the second a Protect-o-Vane controller designed to protect a furnace, oven or process from excess temperatures.

Advantages of the Pyr-o-Vane controller include fast control, absence of motors, and non-cyclic correction. The Protect-o-Vane is designed as a companion-piece for the Pyr-o-Vane controller, many of the components being interchangeable. It can also be used in conjunction with the company's ElectroniK line.

HERE'S HOW...



FAFNIR USES 20 LINDBERG CYCLONES

...to draw thousands of types of bearings!

The Fafnir Bearing Company, New Britain, Conn., uses Lindberg Cyclone Furnaces to draw thousands of types and sizes of its line of ball bearings. They say:

"The metallurgical department of our company entrusts the major part of its drawing operations to Lindberg Cyclone Furnaces because it has found them to be dependable work horses. At the present time there are 20 in use in the Company's three ball bearing plants in New Britain, Conn.

"They have given excellent continuous service for more than 8 years. For long periods they were operated 24 hours a day, seven days a week, (at temperatures ranging from 275 to 1200°F.) without downtime due to furnace failure.

"Because the Fafnir line of ball bearings,comprising thousands of types and sizes, is considered the most complete manufactured in this country, the Lindberg Cyclones draw a considerable variety of parts. The work varies from small to large dense loads (up to 1600 lbs.) of bearing rings, balls and rolls, yet the uniform results demanded for the manufacture of precision products is constantly being achieved—and in an atmosphere of cleanliness and satisfactory working conditions."

Local Offices in every industrial center.

LINDBERG ENGINEERING COMPANY 2451 W. Hubbard Street, Chicago 12, Illinois.

LINDBERG  FURNACES

Rings and blanks of varying diameters produced by the CENTRI-DIE process. Shown as cast and rough-machined.

Lebanon

CENTRI-DIE Castings with

TRADE-MARK

Superior Qualities... Important Advantages

● Only by the Lebanon CENTRI-DIE method can certain parts—cylindrical and circular—be satisfactorily formed.

● Only by the CENTRI-DIE process can many of the new, special heat and corrosion resistant alloys—difficult to forge—be perfectly cast in permanent molds. *This one advantage has been of great importance in the production of this country's jet engines and other super-heat structures.*

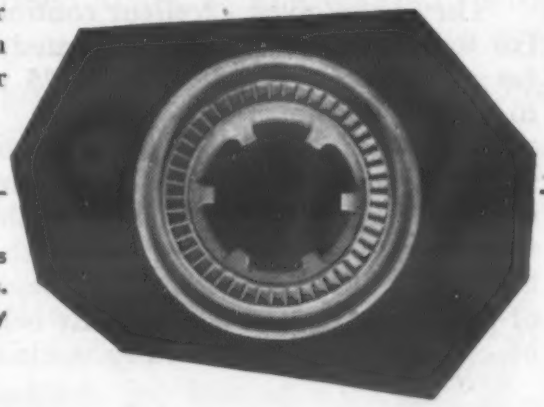
● Only by the Lebanon CENTRI-DIE method do you get these superior physical properties: finer grain structure, greater density, easier machining, more uniform strength and directional properties.

● All CENTRI-DIE castings can be made to meet A.I.S.I., A.S.T.M., A.M.S. Army and Navy Specifications.

You will want to have all the facts on Lebanon CENTRI-DIE Castings . . . we invite you to write for our bulletin or bring your requirements to our engineers.

LEBANON STEEL FOUNDRY • LEBANON, PA.

"In the Lebanon Valley"



Lebanon also produces centrifugal castings in refractory molds—in any quantities. Illustration shows typical casting made by this process.

LEBANON ALLOY AND STEEL Castings

CIRCLE L

News Digest

CONTINUED FROM PAGE 47

fluence of temper brittleness on fatigue properties of chromium and molybdenum-chromium steels; electrical properties of dielectric materials for aircraft cable connectors; high-temperature (4170 F) furnace utilizing thoria-resistor elements; electrical resistance method for following progress of phase transformations in precipitation-hardening stainless steel; soldering technique making possible joints only 0.00002 in. thick; resistance welding of thin gage metal; adapting counter-gravity casting process to applications where controlled pouring rate and running of thin sections are required; and a high conductivity magnet wire which will not change in resistance with temperature.

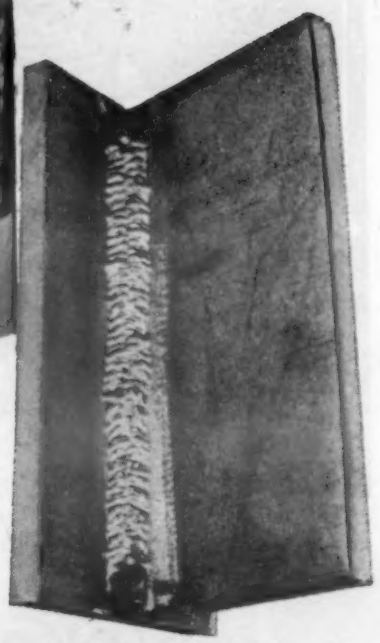
Development of Synthetic Mica May Ease Critical U.S. Supply

Synthesis of mica, generally classified as a critical material, has been announced by the National Bureau of Standards. The synthetic mica is superior to the natural substance in its ability to withstand high temperatures but, in other respects, it has essentially the same properties.

Successful crystallization of mica, widely used as an electrical insulator in the electrical and electronics industries, was accomplished by Dr. Herbert Insley, Alvin Van Valkenburg and Robert Pike, all of the Bureau. The work on synthetic mica is part of a broad program of Bureau research on fluorine-type artificial minerals sponsored by the Office of Naval Research, and was carried out in cooperation with the U. S. Bureau of Mines and Colorado School of Mines. The importance of this development lies in the fact that this country's mica production is only a small fraction of its own requirements.

The synthetic mica contains four minerals: quartz, magnesite, bauxite and a fluoro-silicate compound. It is this latter compound which is believed to make the material superior to natural mica in high temperature resistance. The fluoro-silicate also provides a safe and convenient way of introducing fluorine, known to be a successful crystallizing agent, so

now it can be done!



Specimen of AIRCOMATIC welding stainless—vertical down.

weld stainless steel with new high-speed AIRCOMATIC process

Now, stainless steels in all standard joint designs, in thicknesses of ⅛ inch plus, can be welded faster *in all positions.*

You can make single or multi-layer welds by either beading or weaving. Vertical welds can be made upward or downward. In short, the Aircomatic Process permits the welding of stainless with all the ease and versatility of ordinary steels – at a high rate of deposition and with complete freedom from slag.

Continuous feeding of filler metal, and inert gas (helium or argon) shielding, are the two main features that give this new welding method its exceptional speed and flexibility. A bare filler metal, in wire form, is fed continuously through a manually-operated gun . . . and, of utmost importance, the process deposits a weld metal with an analysis almost identical to the filler wire – even approximately 60% of the titanium in the filler wire is transferred to the deposited metal.

Investigate the many advantages this new *Aircomatic Welding Process,* for welding stainless steels, aluminum and other metals, can offer you. If you desire more information in the form of a descriptive folder, delivery and price data, fill in and mail the coupon below.

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Please send me your folder (ADC-661) describing the welding of stainless steel with the Aircomatic Process and equipment.

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Address_____

Firm_____

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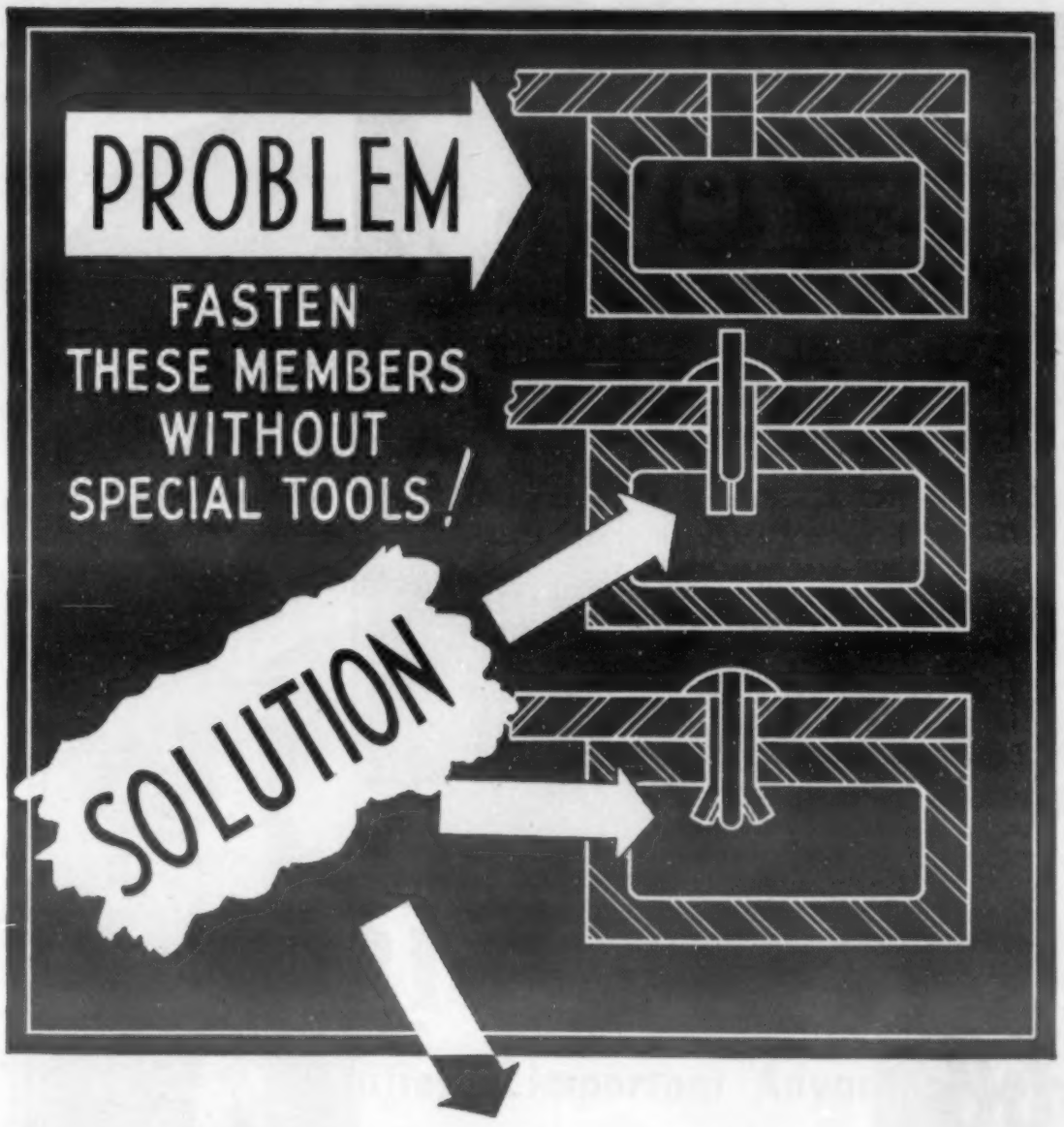

SOUTHCO DRIVE RIVETS

This problem was solved with a SOUTHCO Blind Rivet and a hammer. No special tools required—just *"hit the pin"* — no need to buck or trim. SOUTHCO—the blind drive rivet with the strong "pull-up" is available from stock in modified brazier and 100° countersunk head styles.

Make rivet replacements without removing panels—save on initial installations. Metal-to-metal or metal-to-wood applications cost less with labor-saving SOUTHCO Drive Rivets.

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that the mica can be synthesized satisfactorily at normal atmospheric pressure. In its natural state, mica is the result of a long process involving extremely high pressures and temperatures, but such high pressures would be undesirable in laboratory or production processes.

In the production of synthetic mica, the four powdered ingredients are placed in a platinum-lined crucible and melted in an electrical furnace at a temperature of nearly 2500 F. As the furnace cools, mica crystals grow from a tiny seed at the bottom of the crucible. Ordinarily, the individual mica crystals form groups oriented in many different directions, but, for mass production, the mica crystals should be formed in parallel sheets. In practice, it appears that the desired orientation can be obtained by precision control of temperature differences within the crucible.

High Temperature Symposiums

Two symposiums on the effects of high temperature on metals are scheduled for the annual meeting of the American Society for Testing Materials in Atlantic City the week of June 26. They will cover "The Corrosion of Gas Turbine Materials" and "The Effect of Sigma Phase on the Properties of Metals at Elevated Temperatures."

The papers are sponsored by the Joint Committee on Effect of Temperature on the Properties of Metals, which functions under the auspices of the ASTM and the American Society of Mechanical Engineers.

Careful Control of Tool Design, Cutting Conditions Should Extend Use of Corrosion Resistant Alloys

Although the machining of the work-hardening stainless steels requires a different technique from the machining of ordinary screw stock, careful shop practice should enable manufacturers to further extend the use of corrosion resistant materials. Malcolm F. Judkins (*The Tool Engineer*, Jan. 1950) suggests particular attention to prevention or removal of scale, avoidance or correction of the

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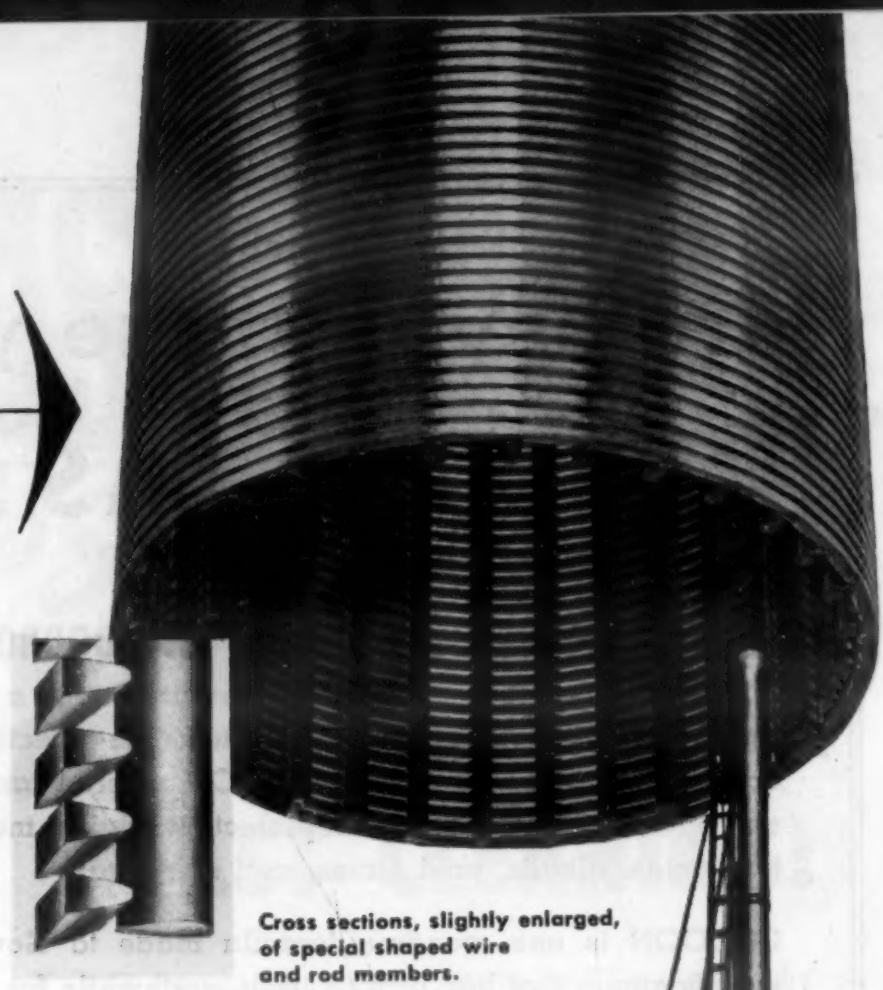
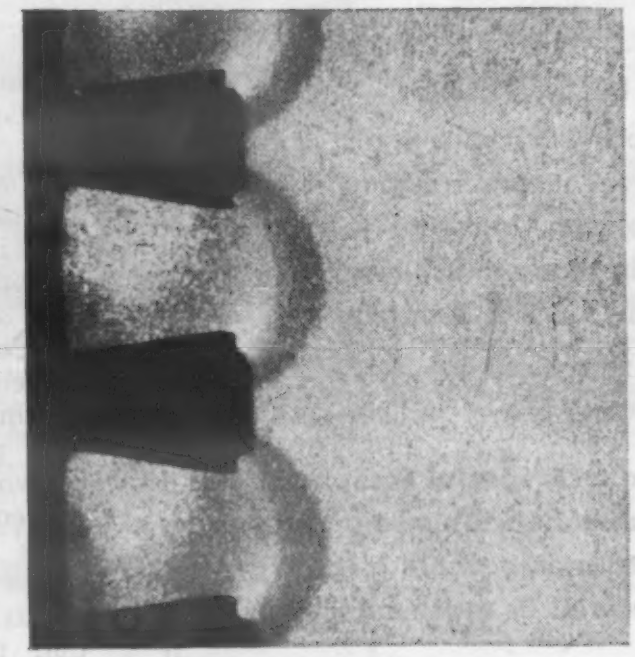
Famous for exceptional resistance to corrosion, high strength, and adaptability to money-saving fabricating methods.



Cross sections, slightly enlarged, of special shaped wire and rod members.

ll screen being fabricated by e method of resistance welding.



Micrograph of lengthwise section showing excellent fusion of Everdur resistance welds.

Johnson Well Screen, 16" O. D., 35' long, being lowered into well casing.

Longitudinal rods and outer wire in this Edward E. Johnson, Inc., well screen are both Everdur* 1010 and of special cross section. Fabrication of the screen is quickly and economically accomplished by rotating the rod assembly, thus winding on the wire and automatically welding wire to rod by electrical contact.

The circuit is arranged so that the rod assembly becomes one electrode, the other electrode being a copper roll which rides on the wire. As the latter touches each rod a surge of current welds the wire to the rod. Welding is at the rate of from 900 to 1700 welds per minute, depending on the size of the wire and rod. Only two or three cycles of current are required for each weld.

Everdur Alloys are non-magnetic and highly resistant to fatigue. Alloys are available which can be machined, hot-forged, drawn, stamped, spun, cast, electric-welded or oxy-acetylene-welded by all modern methods and equipment. For detailed information regarding compositions, properties, applications and advantages, ask for Publication E-5. Our Technical Department is at your service. Write The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 49158

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Where corrosion resistance counts— consider Everdur

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Regardless of the size or shape of your product or equipment, COCOON protective packaging solves moisture-vapor penetration, shipping and storage problems. Machine tools or other equipment can be packaged in ready-to-use condition; completely assembled with operating lubricants in place.

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G. E. COCOON, properly applied, protects special equipment and working surfaces against contamination. This same protection by G. E. COCOON is of outstanding value for acid-proofing in the chemical industry as well as other industries having acid-proofing problems.

Applied with a pressure spray gun
Strips off like a banana peel

Cocoon Provides Protection in the Right Places

Write **COCOON** Reg. U. S. Pat. Off. **ENGINEERING SECTION**

R. M. HOLLINGSHEAD CORP.
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harmful effects of work hardening, selection of the proper cutting tool materials and cutting conditions, and employment of efficient tool design and methods.

Because physical properties must satisfy service requirements as well as machining purposes, optimum machinability is seldom realized. A compromise can be effected by trying to control the hardness within the range of 187 to 229 Brinell and to induce as much brittleness as possible by the combined effect of the alloying elements. A coarse grain size, often preferable for machining, can be obtained by controlling the finishing temperature of the hot work performed before machining is begun.

Cutting Conditions

Tool design, including clearances and other cutting angles, must be selected and maintained with care. Cutting conditions, including feed, cut, speed and cutting fluid, are also important. Tool and cutter performance are influenced by the kind and amount of scale on the surface.

Generally, the technique of machining stainless steels consists of (1) preventive measures, designed to avoid the harmful effects of work hardening; and (2) corrective measures to alleviate the trouble after it has developed. Work hardening effects can be minimized by avoiding dull tools, intermittent feed, tool rubbing, excessive heat generation, spindle float and slide wear, insecurely held tools and work, and minor machine difficulties which stop the machine or retard its speed.

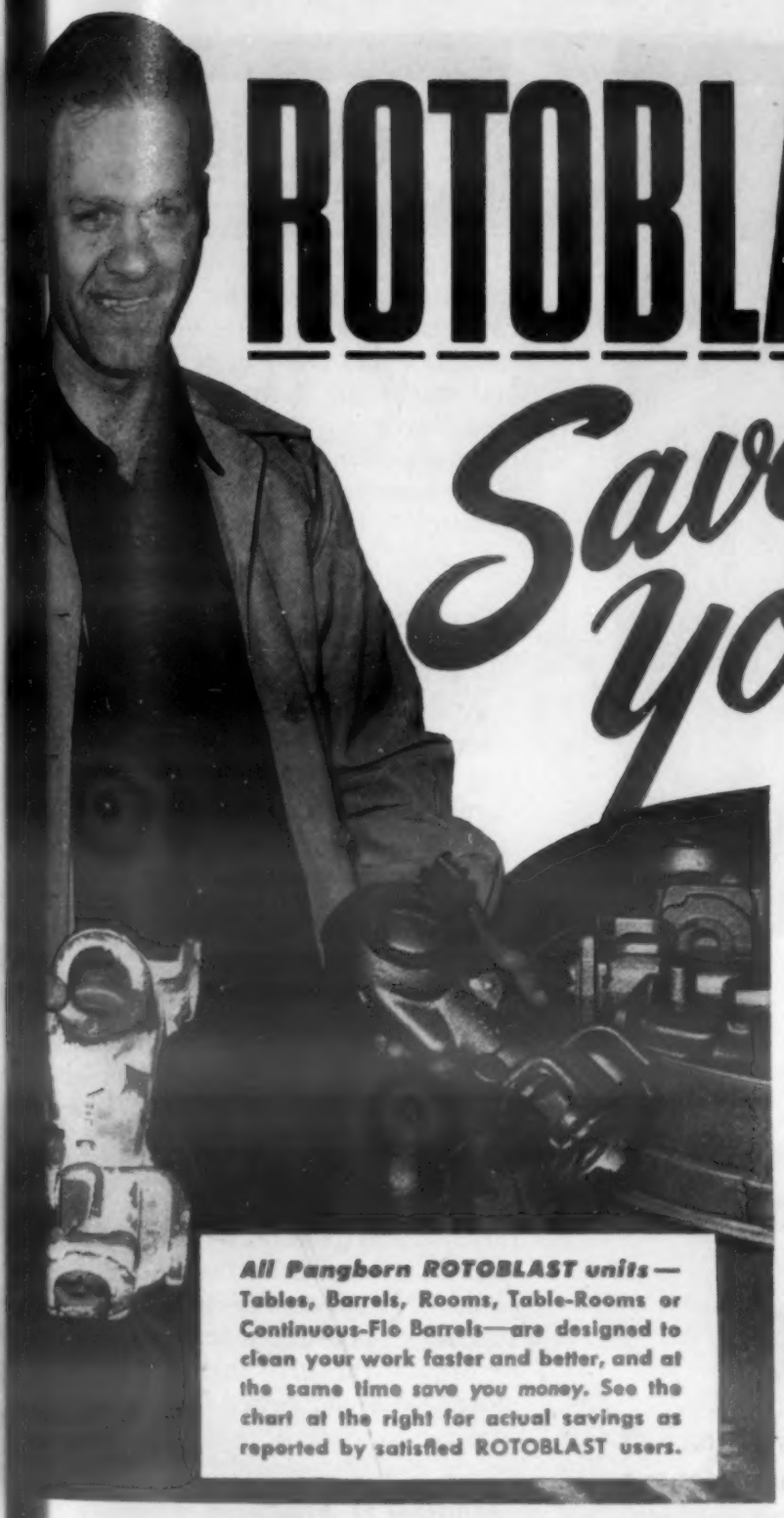
Heat Treatment

For the straight chromium or ferritic stainless steels, best results are obtained by machining in the cold worked or cold worked and annealed condition. In this condition, the machining of ferritic stainless is similar to that of 0.4 to 0.5% carbon steel. Annealing practice for these steels is the same as for similar types of structures desired in carbon steels.

The martensitic and austenitic types of stainless are tough and difficult to machine; avoiding causes of cold work is extremely important. Excessive work hardening can be alleviated by annealing at 1850 to 2150 F, followed by air or water cooling. Annealing temperatures be-

ROTOBLAST*

Saves you $5,000 $11,000 $10,000 $ on BLAST CLEANING!



All Pangborn ROTOBLAST units — **Tables, Barrels, Rooms, Table-Rooms or Continuous-Flo Barrels—are designed to clean your work faster and better, and at the same time *save you money*. See the chart at the right for actual savings as reported by satisfied ROTOBLAST users.**

USE ROTOBLAST and you save money! No matter what you clean: large or small castings, fragile or intricate castings, or any combination—your best bet is ROTOBLAST! Only Pangborn offers you a money-saving ROTOBLAST unit to fit the needs of any foundry, large, medium or small.

Look at the amount of cash ROTOBLAST has saved for actual foundries as reported below. *In every case* ROTOBLAST cut cleaning time, saved labor and maintenance and reduced operating expenses to the tune of thousands of dollars a year.

USERS REPORT IMPRESSIVE SAVINGS WITH ROTOBLAST

ROTOBLAST UNIT	CASH SAVED	NAME OF USER
Table-Room	**$5,452** *on labor and maintenance*	Champion Blower & Forge Co., Lancaster, Pennsylvania
Table-Room	**$11,102** *on labor alone*	Lewistown Foundry, Lewistown, Pennsylvania
Room	**$10,160** *on labor alone*	Harris-Seybold, Cleveland, Ohio
Barrel	**$5,080** *on labor alone*	Yates-American Machine Co., Beloit, Wisconsin

Yes—ROTOBLAST offers the ideal solution to *your blast cleaning problems*. Cleaning efficiency is equally high, whether you operate at 50% or full capacity. To get *faster blast cleaning* in your plant—specify Pangborn ROTOBLAST!

GET THE FACTS! Find out how much money *you* can save with ROTOBLAST. Bulletin 214 contains technical details. Or send us your problem and we'll show you how ROTOBLAST can solve it. But write today . . . just address PANGBORN CORPORATION, 1403 Pangborn Blvd., Hagerstown, Md.

Pangborn ROTOBLAST saves you money these five ways:

- **SAVES LABOR:** *One ROTOBLAST machine and operator can do as much as a two-man crew and old-fashioned equipment.*
- **SAVES SPACE:** *In many cases, one ROTOBLAST machine replaces five or more old-fashioned machines, requires less space.*
- **SAVES TIME:** *Cases on record prove ROTOBLAST can cut cleaning time up to 95.8% compared with old-style methods.*
- **SAVES POWER:** *Modern ROTOBLAST uses but 15-20 h.p. compared to old-fashioned equipment requiring 120 h.p. for same job.*
- **SAVES TOOLS:** *On work cleaned with ROTOBLAST, cutting tools last up to 2/3 longer because no scale is left to dull edges.*

SAVINGS MEAN PROFITS

Look to Pangborn for the Latest Developments in Blast Cleaning and Dust Control Equipment

MORE THAN 25,000 PANGBORN MACHINES SERVING INDUSTRY

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FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION INC. MEMBER FEMA

BLAST CLEANS CHEAPER with the right equipment for every job

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Back of local stocks in Carlson Distributor warehouses is the largest stock of stainless plate in the country—at G. O. Carlson, Inc. The photograph above illustrates just one section of our large plate storage racks—all chemical quality stainless steel in complete range of sizes, thicknesses and analyses. With such a selection ready to draw on, it is obvious that you seldom have to wait.

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1 Fast delivery on stainless plate as rolled or cut to size.

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3 Complete your needs—with Carlson heads, rings (cut from plate or forged and rough machined), diameters, forgings, billets, bars and No. 1 finish sheets.

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low 1750 F should be avoided, because carbides precipitated by heating may not be completely redissolved and machining difficulties will result. Too high temperatures or too long a heating period induces excessive scale and excessive grain growth, causing a rough, orange-peel surface when machined.

Stainless Cutting Device

A device which appears to offer several important advantages in cutting stainless steel welds has been developed by Leo J. Anctil, an electric welder at the Portsmouth (N. H.) Naval Shipyard. Essentially, the device consists of an air pistol combined with welding tongs, with a safety shield protecting the operator.

The unit, which can be used in any position, is claimed to cut stainless steel welds faster and with less removal of weld metal than any other method employed. Since less metal is required, less time and filler metal are used in repairing a flaw, and there is less possibility of obtaining quench cracks. Other advantages include (1) no porosity or pitting, and (2) no carbon deposits on the metal to attract the arc, making the arc more stable and easier to control.

Addition of Powdered Aluminum Produces White Magnetic Fluid, Offering Easier Crack Detection

A new development in magnetic crack detection, reported in the British publication *Iron and Steel* (Jan. 1950), may save inspection time and ultimately reduce the cost of the process. Essentially, the new technique, developed by Metropolitan-Vickers Electrical Co., Ltd., involves the addition to the magnetic fluid of aluminum powder which retains its whiteness when immersed in paraffin.

Magnetic crack detection is an established and reliable method of examining ferrous parts for surface cracks, flaws and fissures. Generally, the method employs a thin oil vehicle such as paraffin containing small particles of magnetic iron oxide in suspension. When the fluid is washed over the surface of a magnetized article, magnetic poles which occur at discontinuities such as cracks or in-

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because it's

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To get *all* of the benefits of Republic ENDURO Stainless Steel, plus the ease-of-fabrication which results from Republic's *exclusive* ELECTRUNITE Process of tube manufacture, always specify ELECTRUNITE Stainless Steel Tubing. You'll find out that it pays *now* as well as in the long run.

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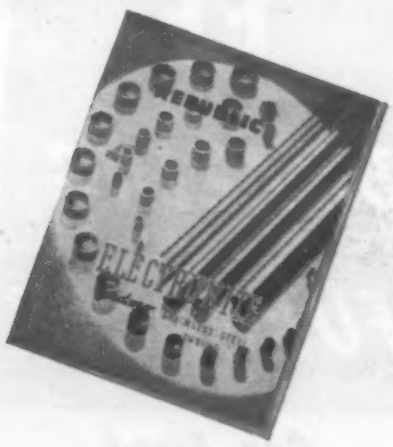

***FREE** 28-page booklet gives the complete story about ELECTRUNITE Stainless Steel Tubing. Contains helpful tables, data and valuable fabricating information. Send for your copy TODAY.*

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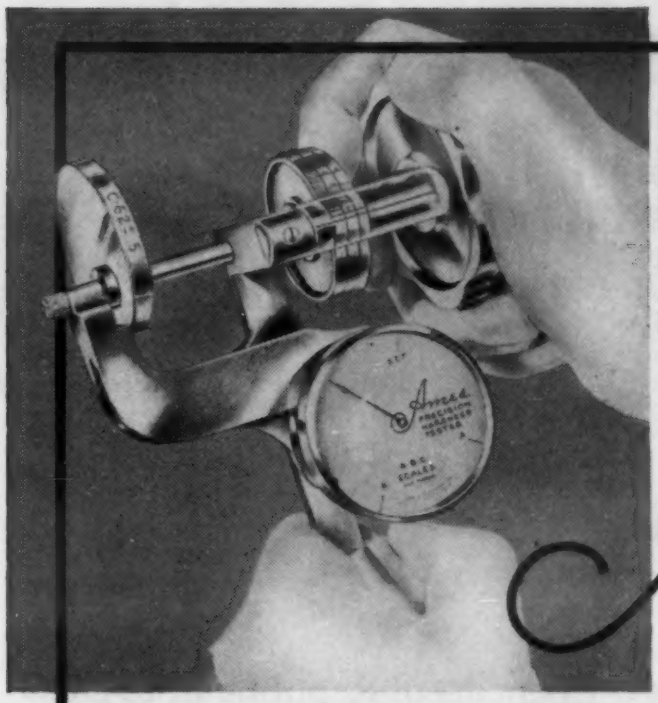

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Amazing savings in time and expense can be realized by taking the Ames Hardness Tester to the work. For hardness testing flat or round stock, tubing, duplicate parts, knives, saws and irregular shaped pieces, reading directly in the Rockwell Scales. No cutting off specimens. No laboratory delays. Complete with wooden carrying case. Several sizes. Write for bulletin.

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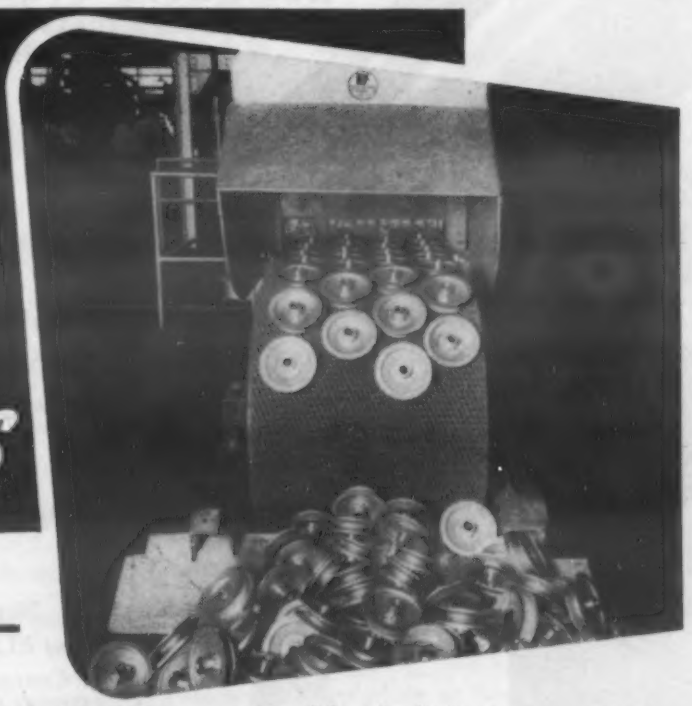
EF BRAZING FURNACES



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● For instance, brazing a disc on the end of a tube may use 75 to 80% LESS material than if the hollow flanged part is cut from the solid. Finishing costs are low too, because the assemblies are discharged smooth and scale-free.

Brazing also avoids localized overheating, distortion and the cost of straightening. It's ideal for most any size, shape or quantity requirement.

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clusions cause the particles to be attracted and collected, thereby indicating the location of the defects.

It is apparent that good color contrast between the particle formation and the surface of the article under test and slow gravitation of the particles in the suspending medium are essential. The black and red particles commonly used are successful on brightly finished surfaces, therefore but not so successful on dark surfaces such as those found on unmachined forgings, stampings and castings.

In the past unsuccessful experiments have been made in an effort to produce a white magnetic fluid. Some materials tried were found to settle too rapidly. But the greatest stumbling block was the tendency for most white powders to become dark when wetted with paraffin. The latest experiments have shown, however, that a powdered light-colored metal of low density—aluminum, for example—can be used successfully. Best results have been obtained by ball-milling a mixture of approximately equal parts by volume of aluminum and iron oxide prior to dilution with paraffin or methylated spirits.

Tests have shown that no reduction in sensitivity of the fluid is caused by the addition of aluminum powder. It is believed that substitution of the white fluid would prove economical wherever large numbers of components, such as unmachined forgings, are being inspected by the magnetic fluid method.

CORRECTION

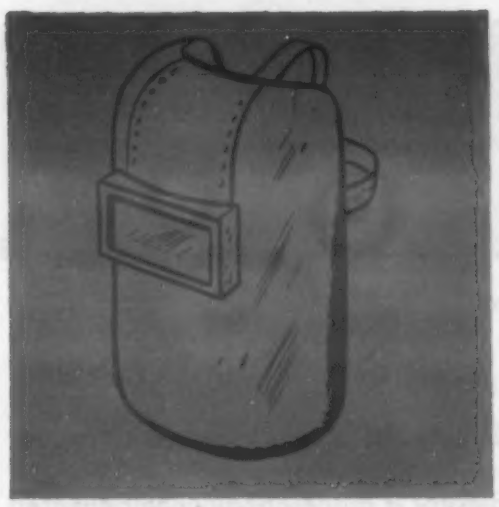
An announcement from the Office of Naval Research, reported in the Dec. 1949 issue of MATERIALS & METHODS (page 41), incorrectly listed the American Electro Metal Corp., Yonkers, N. Y., as the "American Metals Co."

Resistance Welding Papers

A total of $2250 in prizes will be awarded in this year's competition for papers on resistance welding, sponsored by The Resistance Welder Manufacturers' Assn. The contest closes July 31, 1950, and awards will be made at the fall meeting of the American Welding Society.

Prizes of $750, $500 and $250 will

from under many hats



...the soft fedora of the salesman... engineer, the furnace stained cap of the foundry craftsman... the symbolic mortar-board of the scientist... the eerie mask of the welder... these symbolize the skills and traditions necessary to produce finer castings. Side by side, welded by years of experience, the men beneath these hats unite their individual skills to produce the quality and excellence that is known to all industry as a stamped Ⓢ on Sivyer high alloy, low alloy and carbon steel castings.

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Shrink Fits
Sintering
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—and many others

Ask for the scores of ideas in Induction Heating Bulletin 13-A

Cost-conscious engineers who have used high frequency for forging and heavy heating operations, state that induction heat gives lower overall cost of finished pieces—plus closer quality control and cleaner, more comfortable shops.

Ajax-Northrup heat is so fast, it's practically scale-free. Often you can use smaller diameter stock. There's less down time for die cleaning, costly dies last longer, and closer dimensions save machining.

No heat is wasted—you heat only the section you're going to work. Automatic timing means exact temperature, and by arranging heaters in banks right next to the forging machine, you provide constant flow of hot bars paced for maximum production.

Change-overs from one heating or melting job to another are easy. One heater can handle many different billets within its efficiency range, and different sizes of heaters can be added at low extra cost. Plan now for continued production savings with Ajax-Northrup heat.

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ONE Indicator Plug Connects to any of SIX Thermocouple Jacks

MULTI-POINT PYROMETER INDICATOR

Fast Simple Versatile Accurate Compact Trouble-Free

Designed to indicate temperatures for various applications.

Indicator is automatically compensated for cold junction temperature changes and instrument temperature resistance coefficient.

Available in five temperature ranges, either Fahrenheit or Centigrade.

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If you will advise us the details of your application, we will recommend suitable equipment or, for additional information request our Catalog Section 25G.

Thermo ELECTRIC CO.
FAIR LAWN, N.J.

News Digest

be awarded for the best papers from industrial, private or government sources. Additional prizes are offered for papers from university sources. Further information is available from the Association, 505 Arch St., Philadelphia 6, Pa.

Metallurgical Specimens Can Be Mounted at Room Temperature

Metallurgical specimens can be mounted at temperatures only slightly above room temperature and without the external application of heat using a method developed recently by Denton L. Smith of the National Bureau of Standards.

In all common mounting procedures, the specimen is heated to a high temperature under pressure, which sometimes causes recrystallization and change in the structure of the metal. Moreover, rather expensive equipment is usually required. The Bureau's method, on the other hand, can be carried out in 15 to 30 min., depending upon room temperature, without the use of special equipment other than an inexpensive mold and a clamp or vise.

A denture material of modified acrylic resin is employed as the mounting. This material consists of a polymer and monomer which, when mixed in the proper proportions, will polymerize or set under pressure at room temperature. As the amount of heat generated by the polymerization reaction can be controlled by varying the amount of resin present, the new procedure makes it possible to mount a wide variety of specimens for polishing and microscopic study without disturbing the crystal structure.

NEWS OF

Engineers

William B. Moore, Jr. has joined Reynolds Metals Co. as a technical service engineer, where he will be engaged in development work in the application of aluminum in the chemical and petroleum industries.

The United States Steel Corp. announces the election of *Stephen M. Jonks* as vice president in charge of operations of its subsidiary, Carnegie-Illinois Steel Corp. Mr.

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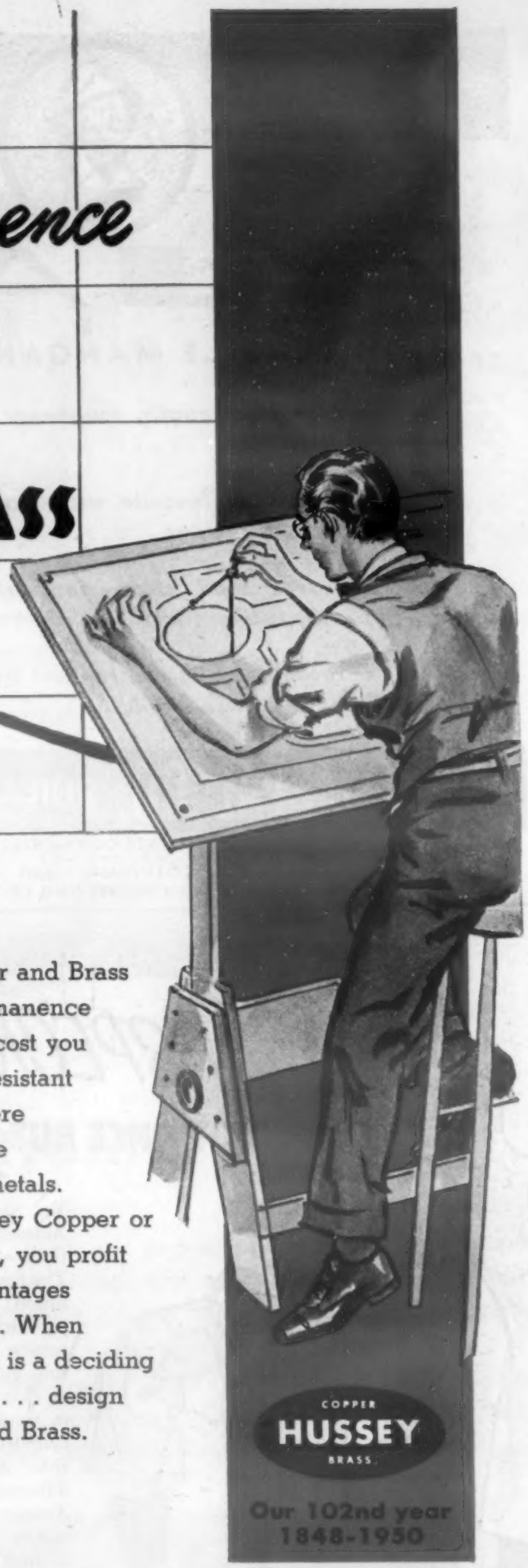
Give Your Products

Dependability at Low Cost



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Versatile Hussey Copper and Brass give your products permanence and dependability at a cost you can afford. Corrosion resistant and durable under severe service conditions, these truly are the *ageless* metals. When you design Hussey Copper or Brass into your product, you profit by the cost-saving advantages of simplified fabrication. When permanence at low cost is a deciding factor in your products . . . design with Hussey Copper and Brass.

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Fabricated Products (Rods . . .
Wire . . . Tubing . . . Nails)

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- *long time favorite with manufacturers of marine fittings . . . . . .*
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Mathieson CHEMICALS

8111

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH

News Digest

Jenks, formerly manager of operations for the company's Chicago district, succeeds *James E. Lose*, who was recently elected executive vice president. At the same time, *William C. Oberg*, manager of operations for the Pittsburgh district, was elevated to the position of general manager of operations for Carnegie.

David C. Peterson has been named director of engineering and manufacturing of Division One of Stewart-Warner Corp. Mr. Peterson assumes the duties relinquished by *George Thomas*, who was appointed production consultant to the senior vice president of the company.

The appointment of *Lyman C. Athy* as technical assistant to the president of Pemco Corp. has just been announced. Mr. Athy has had 25 years of production, research and development experience in the porcelain enamel industry.

John McVeigh has joined Kennametal, Inc. as special development engineer, and will do research work pertaining to the application of the company's new heat resistant material Kentanium, particularly to gas turbines. Mr. McVeigh previously served as project engineer for Continental Motors Corp. It was also announced that *C. J. Marlett*, representative for Kennametal in the Chicago district, has been transferred to the Engineering Dept. at Latrobe, Pa., as project engineer.

The Norton Co. recently elected *Milton F. Beecher* vice president in charge of research and development. Mr. Beecher previously served as director of research for Norton. *George N. Jeppson* and *Milton P. Higgins* were re-elected as chairman of the board and company president, respectively. And *Ralph F. Gow*, executive vice president of Norton, was elected vice president of Norton Pike Co., and *Ralph M. Johnson*, vice president in charge of sales at Norton, was named to the Norton Pike Co. board.

Leroy A. Critchfield has joined the Standard-Thomson Corp. as director of its chemical and metallurgical laboratory. Mr. Critchfield had been head of the Dayton, Ohio office of United Chromium, Inc.

The General Electric Co. has announced the retirement of Dr. *Albert W. Hull* from his post as assistant director of the G.E. Research Laboratory. Dr. Hull, who is credited with the invention of more types of electron tubes than any other man, will continue to serve the laboratory as a consultant.

Walter F. Munford was promoted to the position of vice president in charge of operations of the American Steel & Wire Co. He assumes the office vacated by *Harvey B. Jordan*, now president of this United States Steel Corp. subsidiary.

The National Military Establishment has appointed Dr. *Robert F. Mehl* chairman of the committee on metallurgy of the Re-

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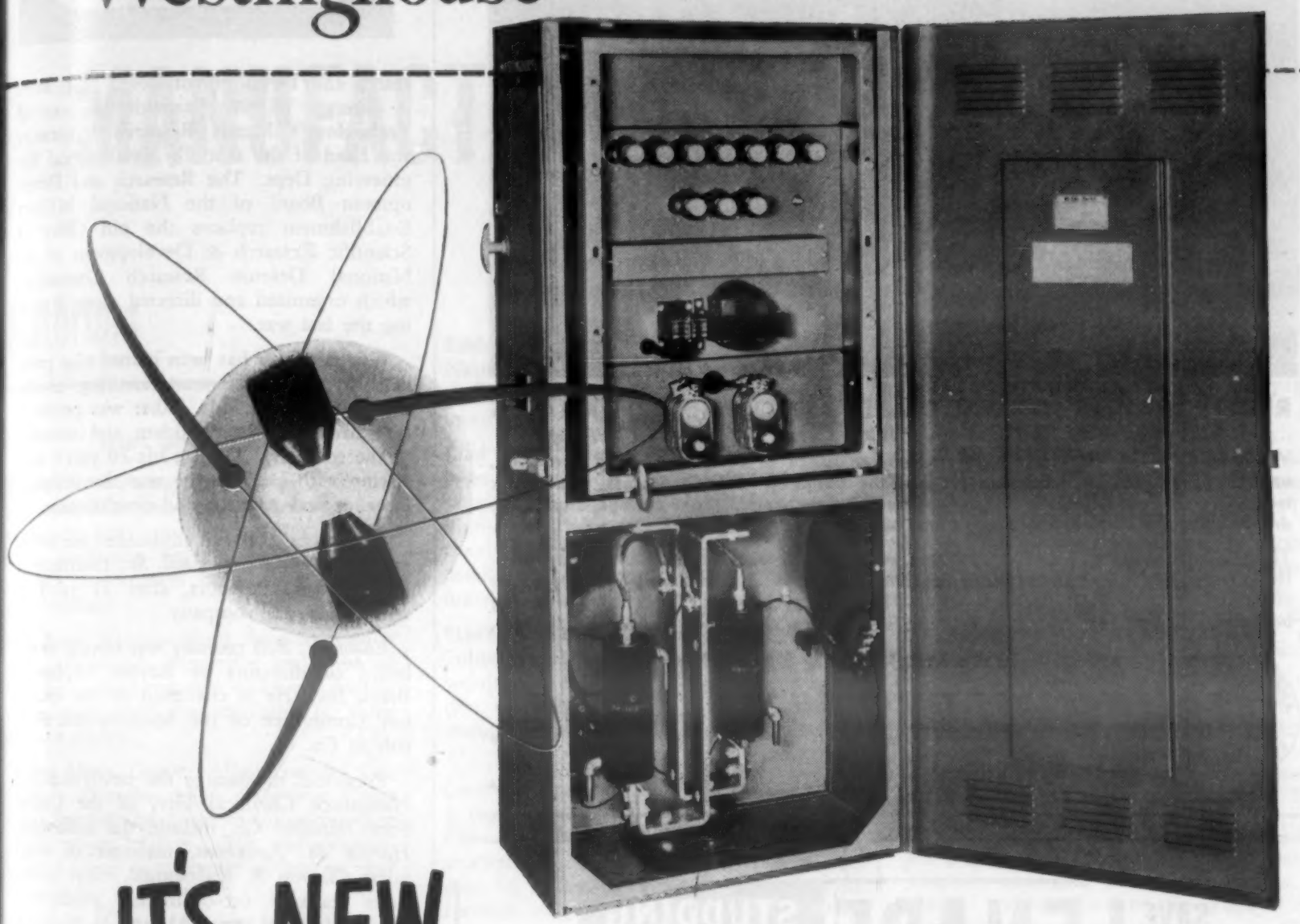

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Look inside the new Westinghouse Resistance Welding Control and you'll spot many important advances in control design: reduced size . . . fewer components . . . a control panel that lifts out of place easily and individual control panels that can be removed separately. You'll find pay-off features everywhere.

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THE RECIPROCATING MUFFLE advances work through the heat by its own momentum. Heat losses and maintenance problems are reduced to a minimum by the complete elimination of conveying mechanism from the heating chamber. There is no traveling belt to be alternately heated and cooled—only work enters and leaves the furnace.

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Studding outlets, naturally short in height and providing reinforcement of the opening, have design appeal, economy in price and fabrication, and advantages in use.

Important applications include inter-deck access openings on small diameter towers or columns, boiler mountings, clean-out or observation ports, and similar uses in close-clearance locations.

Welding type studding outlets in wide range of sizes and ASA standards, and riveting type in 150lb. and 300lb. Standards are detailed in Catalog 9-49.

While available in mild and Stainless steels, sizes 6" and larger can be furnished stainless lined and faced for best economy on clad or solid stainless constructions.

WELDING TYPE

WELDING TYPE

RIVETING TYPE

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RED MAN PRODUCTS

News Digest

search and Development Board. Dr. Mehl is director of the Carnegie Institute of Technology's Metals Research Laboratory and head of the school's Metallurgical Engineering Dept. The Research and Development Board of the National Military Establishment replaces the old Office of Scientific Research & Development of the National Defense Research Committee, which organized and directed research during the last war.

Guy A. Baker has been named vice president in charge of manufacturing of the Duriron Co., Inc. Mr. Baker was previously assistant to the president and secretary of the company. During his 20 year's association with Duriron, he was also active in metallurgical research and development.

Heppenstall Co. has announced the retirement of *S. B. Heppenstall, Sr.*, chairman of the board of directors, after 51 years of service with the company.

Elliott V. Bell recently was elected to the board of directors of Revere Copper & Brass, Inc. He is chairman of the Executive Committee of the McGraw-Hill Publishing Co.

Personnel to manage the newly-acquired Naugatuck Chemical Div. of the United States Rubber Co. include the following: *Harold M. Parsekian,* manager of vinyl sales; *Clayton F. Ruebensaal,* vinyl operations manager (co-ordinating production, engineering and research); and *M. N. Hilseberg,* manager of the Baltimore office. Similar positions were held by these men in the Glenn L. Martin organization before sale of the division. They and other members of the Baltimore office will be transferred to the division office in Naugatuck, Conn., sometime this summer. In the meantime, mail for the Marvinol vinyl plastics operations should be addressed to Naugatuck Chemical, 501 E. Preston St., Baltimore 2, Md.

Leon F. Miller, sales manager, has been promoted to the position of vice president in charge of sales and engineering of the Foundry Machinery Div. of the Osborn Manufacturing Co.

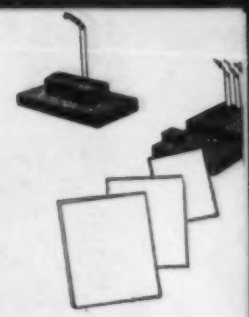
Election of *Joseph A. Martino* to the board of directors of Allegheny Ludlum Steel Corp. has just been announced. Mr. Martino is president of National Lead Co.

G. E. Batzel, general manager, and *M. A. Glaser,* technical director, were named vice presidents of the Midland Industrial Finishes Co. They will continue to head the operational and technical divisions.

The Riverside Metal Co. has appointed *George Peterson, Jr.* manager of its new Special Products Div. For the past year Mr. Peterson was a consulting engineer, with offices in Philadelphia.

William H. Lehmberg recently was elected vice president of the American Felt

(Continued on page 132)



MANUFACTURERS' LITERATURE

Materials

Iron and Steel

Stainless Steel. Armco Steel Corp., 12 pages, illustrated. How stainless steel can be used to reduce costs and improve quality of textile machinery. Table gives resistance of stainless to corrosion by various dyestuffs and chemicals. (1)

Alloy Steel. Chicago Steel Foundry Co., 8 pages, illustrated. Properties and uses of Evansteel, a high-strength nickel-chromium-molybdenum steel manufactured in three different grades. (2)

Casting Alloys. Cooper Alloy Foundry Co., 6 pages. Contains 1950 Reference Chart listing stainless, heat and corrosion resistant casting alloys. Gives alloy designations, room and high temperature properties, and applications. (3)

Alloy Mold and Die Plate. W. J. Holliday & Co., 4 pages, illustrated, No. 905. Properties and uses of Speed Alloy, a deep-hardening, strong and machinable alloy steel plate for molds and dies. (4)

Steel Bars. La Salle Steel Co. Reviewed previously. How Stressproof cold-finished carbon steel bar cuts costs because of its strength, machinability, wearability and minimum warpage. (5)

Iron Castings. Meehanite Metal Corp., 4 pages, illustrated, No. 32. Reviewed previously. Detailed tabular summary of physical properties of Meehanite castings. (6)

Cast Steels. Steel Founders' Society of America, 18 pages, illustrated. A graphic study of some mechanical properties of cast steels, their response to different heat treatments, and the effects of adding alloys to plain carbon cast steels. (7)

High Temperature Steels. U. S. Steel Corp., 87 pages, illustrated, No. ADV-18566. "Steels for Elevated Temperature Service" covers measurement of flow under stress at elevated temperature, factors affecting high temperature properties, and behavior of steels at elevated temperature. Presents valuable tabular and graphical data on high temperature properties. (8)

Bright Annealed Stainless Strip. Wallingford Steel Co., 2 pages, illustrated. Data sheet on 18:8 bright annealed stainless strip, up to 15 in. wide and from 0.005 to 0.070 in. thick. (9)

Nonferrous Metals

Babbitt Metals. American Brake Shoe Co., National Bearing Div. How to specify, melt and pour babbitt metals for longer bearing service. (10)

Clad Metal. American Cladmetals Co., 46 pages, illustrated. Series of data sheets on Rosslyn Metal, stainless- or Inconel-clad high-conductivity copper. Physical and mechanical properties, specifications, prices and detailed information on welding, blanking, drawing and spinning. (11)

Bronze. American Crucible Products Co. Folder on Promet bronze for bearing and wearing parts. Tables give physical properties and compositions, and list recommended grades for specific applications. (12)

Corrosion Resistant Alloy. Burgess-Parr Co., 4 pages, illustrated, reprint from 1948-49 *Chemical Engineering Catalog*. Physical properties, uses and extensive corrosion data on Illium "G," nickel-base corrosion resistant alloy. (13)

Bearing Alloys. Lumen Bearing Co., 158 pages, illustrated. Handbook for engineers and machine designers includes compositions and properties of this company's bearing alloys, and other technical information. (14)

Investment Casting Alloys. Precision Metalsmiths, Inc., 8 pages, illustrated. Data sheets giving composition, heat treatment and physical and mechanical properties of the 80 alloys precision cast by this company thus far. (15)

Aluminum Products. Revere Copper & Brass, Inc., 18 pages, illustrated. Properties of this company's wrought aluminum alloys. Shows products fabricated from extruded shapes, tube and coiled sheet. (16)

Nonmetallic Materials

Carbide Selection. Adamas Carbide Corp., letter-size chart. Useful chart of grade recommendations of all tungsten carbide manufacturers for chip removal, wear and impact applications. (17)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 129.

Ceramics. American Lava Corp., 4 pages, No. 248. Chart of mechanical and electrical properties of AlSiMag ceramics. (18)

Abrasives. The Carborundum Co., 32 pages, illustrated, No. A111. Booklet explains development of company and its products, Carborundum, Aloxite, Globar and MX, for use in abrasive, electrical and refractory applications. (19)

Glass. Corning Glass Works, illustrated, series of six single-sheet bulletins. Series entitled "Why Glass?" describes use of glass in several domestic products. (20)

Synthetic Rubber. E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Div., 8 pages, illustrated, No. 1c/2. Shows uses of Neoprene in hose, gaskets, belts, molded goods, extruded strip and tubing, protective coatings, sponge, wire and cable, adhesives, etc. (21)

Plastics. General Electric Co., Plastics Div., 16 pages, illustrated, No. lb/13. Characterestics and uses of various grades of molded and laminated plastics. Physical and mechanical properties listed. (22)

High Strength Ceramics. Landes, Zachary & Peterson, Industrial Ceramics Div., No. 1049. Technical information, including specific properties, on Coors high strength ceramics for mechanical and electrical uses. (23)

Plastics. Monsanto Chemical Co., Plastics Div. Describes properties and applications of this company's Lustrex styrene and other plastics. (24)

Colored Rubber. Stalwart Rubber Co., 4 pages, illustrated. "Your Color in Rubber" outlines this company's facilities for duplicating any color in rubber, regardless of shade or tone, without altering other characteristics. (25)

Parts and Forms

Perforated Metals. Accurate Perforating Co., 23 pages, illustrated, No. 6. Pictures patterns and lists specifications for varied line of perforated sheet of ferrous and nonferrous metals. (26)

Ring-Shapes. Dresser Manufacturing Div. of Dresser Industries, Inc., 8 pages, illustrated. Shows how designing product as weldment combining ring-shapes can save weight and money. (27)

Nonferrous Castings. Eclipse-Pioneer Div. Foundries. Reviewed previously. "Book of Facts" on modern techniques and equip-

MANUFACTURERS' LITERATURE

ment used in producing sand, permanent mold, die, and precision plaster mold castings of magnesium, aluminum and bronze. (28)

Flexible Tubing. Flexible Tubing Corp., 8 pages, illustrated, No. 5-4. Applications and performance data on Spiratube, new flexible tubing for ventilation and products conveying. (29)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pages, illustrated. Properties and advantages of Graphalloy grades for bushings and electrical uses. Bearing design data given. (30)

Perforated Materials. Harrington & King Perforating Co., 128 pages, illustrated, No. 62. Complete catalog of available styles and sizes of perforated sheet fabricated from ferrous and nonferrous metals, rubber and plastics. (31)

Welding Neck Flanges. Harrisburg Steel Corp., 32 pages, illustrated. Complete catalog of drop-forged steel flanges, including dimensions, prices and service pressure ratings for various materials. (32)

Industrial Bearings. Johnson Bronze Co., 84 pages, illustrated, No. 500. Complete catalog of this company's bushings, bearings, bar bronze and babbitt metal. (33)

Welded Steel Tubing. Jones & Laughlin Steel Corp., 16 pages, illustrated, No. AD-64. Describes manufacture, advantages and uses of Electricweld tubing. Includes tolerances, bending and finishing data and selection factors. (34)

Metal Powder Parts. Michigan Powdered Metal Products Co., Inc., 2 pages. Brief outline of characteristics of powdered metal compacts. Six different materials described. (35)

Stampings. Motors Metals Manufacturing Co., illustrated. Brochure traces company history and shows facilities available for manufacture of wide variety of stampings. (36)

Metal Powder Parts. Plastic Metals Div. of National Radiator Co., 4 pages, illustrated, No. 567. Reviewed previously. Describes some of the more important applications for this company's iron, steel, nickel, manganese and silicon powders. (37)

Deep-Drawn Shapes. Pressed Steel Tank Co., 4 pages, illustrated. Advantages of Hackney process for producing deep-drawn shapes and shells. Typical applications pictured. (38)

Welded Steel Tubing. Republic Steel Corp., Steel & Tubes Div., 8 pages, illustrated, No. 1a/22. Composition, properties and uses of Electrunite electric welded mechanical and pressure steel tubing. (39)

Aluminum Extrusions. Reynolds Metals Co., Technical Editorial Service, Louisville, Ky., 138 pages, illustrated. Available free when requested from Reynolds on company letterhead. "Designing with Aluminum Extrusions" explains engineering principles involved, gives examples of effective extrusion design, and explores manufacturing possibilities.

Beryllium-Copper Tubing. Superior Tube Co., 4 pages. Data on properties of Weldrawn beryllium-copper tubing produced by this company. (40)

Plastic Tubing. U. S. Stoneware, 24 pages, illustrated, No. T-77. Properties, chemical resistance and uses of the six grades of Tygon Plastic Tubing. (41)

Weldments. Van Dorn Iron Works, 16 pages, illustrated. Reviewed previously. Advantages of using welded steel construction in the design of machine bases and other supporting units. Company's facilities described. (42)

Coatings and Finishes

Aluminum Paints. Aluminum Co. of America, 24 pages, illustrated, No. AD 156. Lists seven advantages of aluminum paint, shows many industrial applications, and discusses specific problems in connection with selection and use of aluminum paints. (43)

Protective Coating. Dampney Co. of America, Marine Dept., 2 pages, No. 1560. Characteristics of Dampney Vinyl Coating for metals described. Specifications listed. (44)

Protective Finishes. Gates Engineering Co., 4 pages, illustrated. Advantages and industrial maintenance and marine uses of Gates vinyl finishes and coatings. (45)

Strippable Film. R. M. Hollingshead Corp., 16 pages plus four specification sheets, illustrated, No. 6243. When to use and how to apply Cocoon, a vinyl plastic strippable film for packaging and protection. Complete specifications. (46)

Protective Coatings. Maurice A. Knight Co., 8 pages, No. 3M. Describes characteristics and applications of Pyroflex lacquer coatings for resistance to acids, alkalis, oils, etc. Instructions for preparing surface and applying coating. (47)

Zinc Dust Paints. New Jersey Zinc Co., 36 pages, illustrated. Reviewed previously. Characteristics and uses of zinc dust paints, most adherent paints for galvanized iron and sheet zinc. (48)

Wrinkle Finishes. New Wrinkle, Inc., illustrated. Folder showing typical products utilizing Wrinkle finishes. (49)

Rust-Preventing Oil. Oakite Products, Inc., illustrated, No. F. 7708. Folder on Oakite Special Protective Oil for protection against rust. When and how to use it. (50)

Methods and Equipment

Heat Treating and Heating

Refractories and Alloys. Electro Refractories & Alloys Corp., 98 pages, illustrated. Discusses features and applications of "super" refractories, high temperature cements, Tercod crucibles, Buffalo grinding wheels, Electric stopper heads and Electroloys (casting alloys). (51)

Induction Heating. General Electric Co., Apparatus Dept., illustrated, No. GEA-4945. Shows how a number of manufacturers are using this company's electronic induction heaters to cut costs and speed up production. (52)

Furnace Atmosphere Indicator. Claud S. Gordon Co., 2 pages, illustrated. Describes device which quickly indicates any deviation from desired furnace atmosphere. (53)

Salt Baths. Heatbath Corp., 20 pages. Series of technical data sheets on this company's line of salt baths for the heat treatment and cleaning of metals. Physical and chemical characteristics, operating details, precautions and applications. (54)

Martempering Bath. E. F. Houghton & Co., 4 pages. Description and properties of a high-flash-point oil designed for heat treating operations below salt bath temperature ranges, such as martempering and austempering. (55)

Furnace Tubes. C. O. Jelliff Manufacturing Corp., 10 pages, illustrated. Describes tube elements for high temperature furnaces produced by Aktiebologet Kanthal of Sweden and available through C. O. Jelliff. (56)

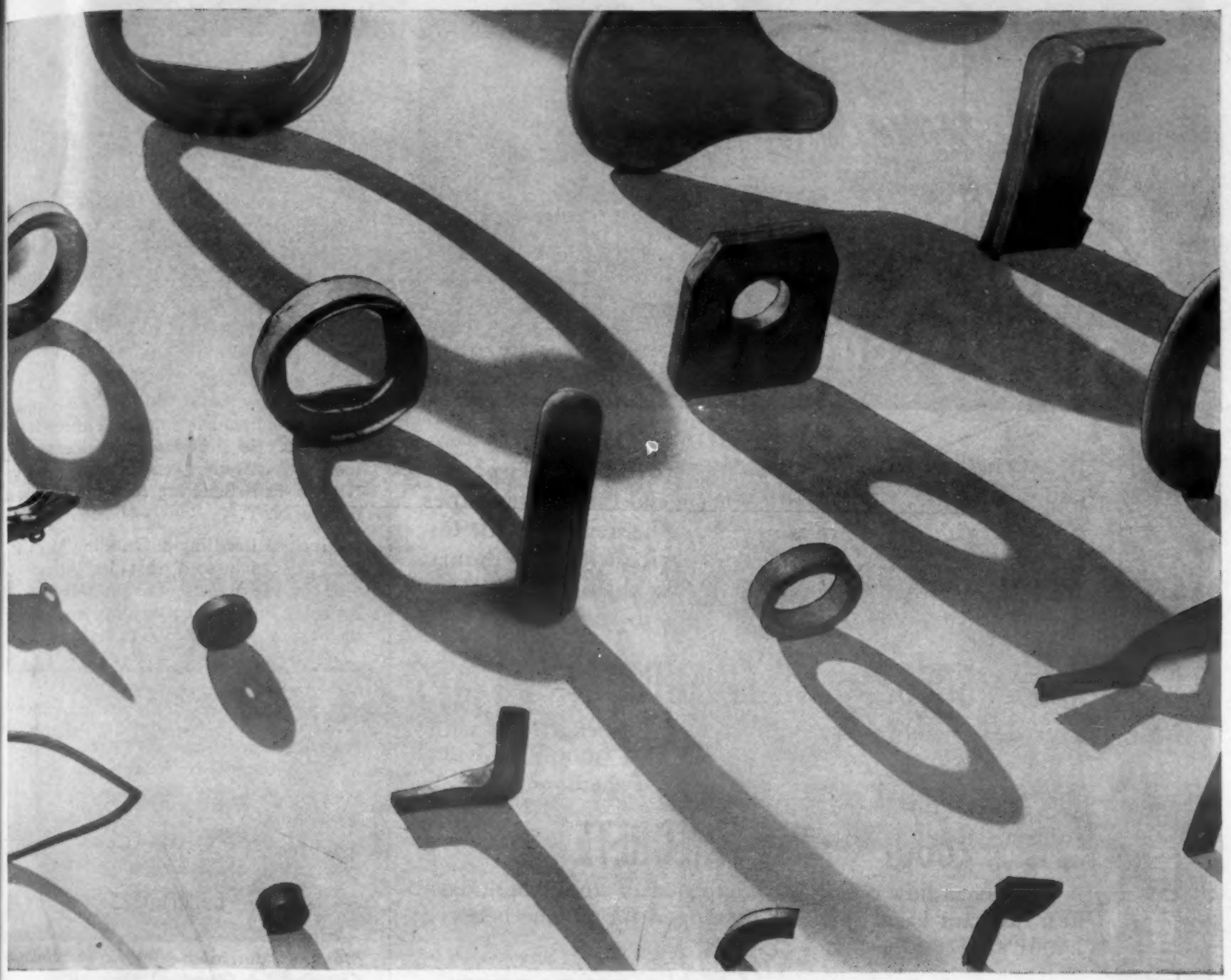
Refractories. Kaiser Aluminum & Chemical Sales, Inc., Chemical Div., 4 pages, illustrated. Describes facilities for production of industrial refractories, chemicals and alumina. (57)

Furnace Control. Leeds & Northrup Co., 4 pages, illustrated, No. ND-600 (1). Detailed description of a "packaged equipment" that regulates efficiently the temperature, pressure and air-fuel ratio variables in furnace installations. (58)

Furnaces and Controls. L. H. Marshall Co., 4 pages, illustrated. Describes high temperature furnace and control panel used for accurate laboratory investigations. Specifications included. (59)

Heat Treating Equipment. Ohio Steel Foundry Co., 8 pages, illustrated, No. F 347. Describes roller-rail assemblies, tubes, hearth plates, fixtures, trays, carburizing boxes, etc., fabricated of Fahrite heat-resisting cast alloys. (60)

Processing Carriers. Rolock, Inc., 36 pages, illustrated, No. B-7. Shows complete line of carriers used in quenching, tempering, carburizing and other heat treating opera-



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In some minds Spongex cellular rubber is a vibration pad for huge hydraulic presses, to others it is a powder puff. For other thousands Spongex is of a density and compression range that was especially compounded to do their job best. There seems to be no limit to man's imagination in creating new uses for Spongex.

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CAST SPECIAL SHAPES QUICKLY . . . EASILY

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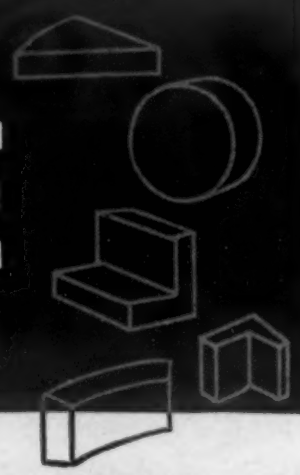

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For use up to **3000F — 3X FIRECRETE**

This new member of the Firecrete family effectively withstands soaking temperatures up to a full 3000F. Provides savings through longer life and reduced shutdowns.

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A high heat-duty refractory composed of an exceptionally heat-resistant base. Specially developed for service between 2400F and 2800F.

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The most generally applicable type of Firecrete. Finely ground, permitting casting of shapes or linings as thin as 1½".

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A lightweight insulating refractory concrete with unusually low thermal conductivity, low heat storage capacity and high resistance to spalling.

The above Firecrete materials can be used in combination where varying temperature and service conditions are encountered.

For patching and gunning, use 3X BLAZECRETE. For temperatures to 3000F. It has exceptional adherence qualities, can be flipped into place with a trowel without ramming or tamping.

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FIRECRETE

"The Standard in Castables"

News Digest

Co. He is chief engineer and general manager of the Glenville, Conn., plant of the company.

The Ajax Electric Co., Inc., has named *Fred W. Schlapp* as sales engineer for Nevada and northern California. His office will be located at 204 Davis St., San Francisco 11, Calif.

Herbert O. Jarvis was elected a director of the Continental Copper & Steel Industries, Inc. He is also vice president of the company, as well as general manager of the Niagara Falls Smelting & Refining Div. at Buffalo, N. Y.

Cincinnati Milling & Grinding Machines, Inc. has announced that its director of research, *Hans Ernst*, was recently honored by being selected outstanding engineer of the year in the city of Cincinnati.

Major *Albert B. Cudebec*, vice president of Hydropress, Inc., died suddenly of a heart attack at the age of 72. He was buried in the Arlington National Cemetery.

NEWS OF

Companies

Allied Research Products, Inc., Baltimore, Md., has purchased the *R. A. Hoffman Chemical Co.*, Cleveland, Ohio. R. A. Hoffman, formerly owner of the Hoffman company, has joined Allied Research and will be in charge of the development of new types of organic finishes. Mr. Hoffman will remain in his research laboratory in Cleveland until new laboratories have been completed in Baltimore.

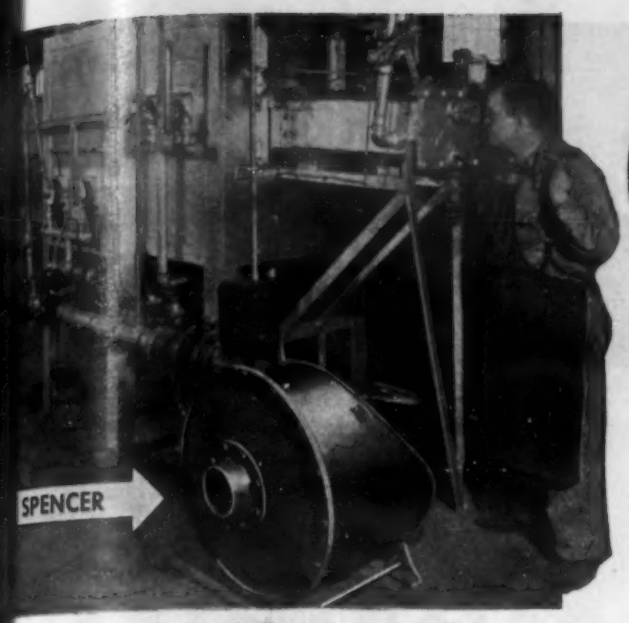
The first hot rolled strip mill ever to be located in eastern Pennsylvania was recently placed in operation in Conshohocken by the *Alan Wood Steel Co.*

The *Claud S. Gordon Co.*, Chicago 16, Ill., announces the completion of an arrangement with Harry L. Campbell, well-known consultant on foundry practice, for the manufacture and sale of the foundry testing equipment developed by Mr. Campbell. It will be marketed as the Gordon-Campbell Foundry Testing Equipment. Complete descriptive literature covering the equipment will be available shortly.

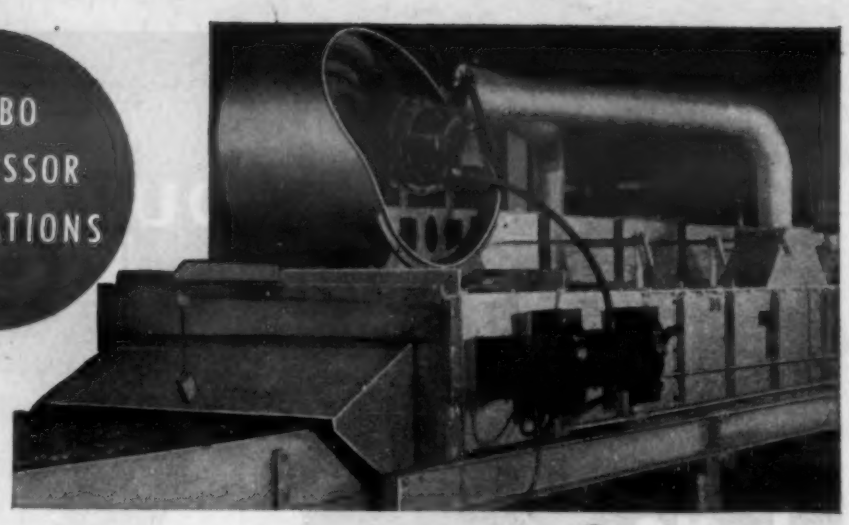
A new Brass Mill Products depot containing expanded sales office facilities has been erected at 4105 W. Chicago Ave., Chicago 51, Ill., by *Scovill Manufacturing Co.*, Waterbury, Conn.

Cowles Chemical Co., Cleveland, Ohio, has moved its research and development laboratory from the campus of Syracuse University to enlarged quarters at 105 S. Townsend St., Syracuse, N. Y.

Purchase of the *Drying Machinery Div.* of *Hersey Manufacturing Co.*, Boston, Mass.,



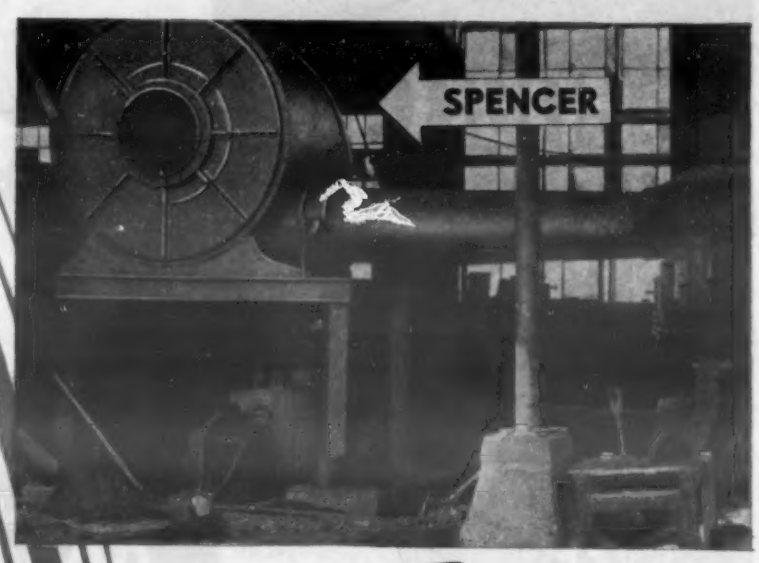
TURBO COMPRESSOR APPLICATIONS

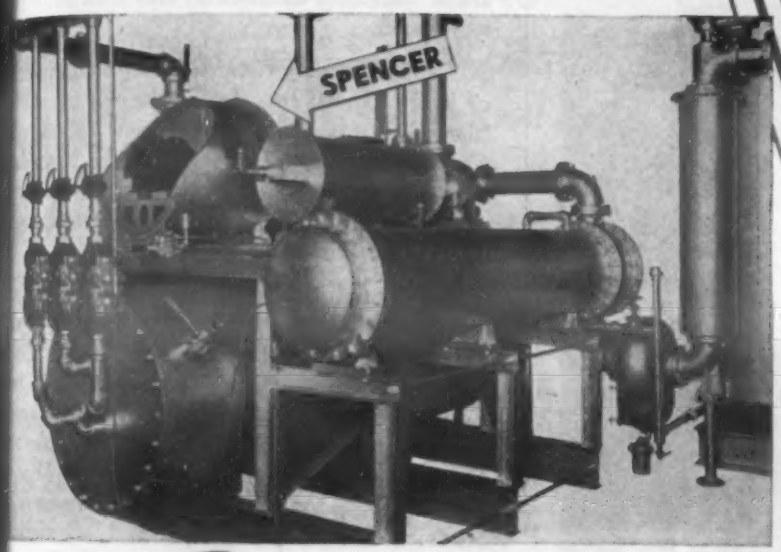


Ask for the Spencer Turbo Data Book and any of the bulletins mentioned.

Cooling
BULLETIN No. 127

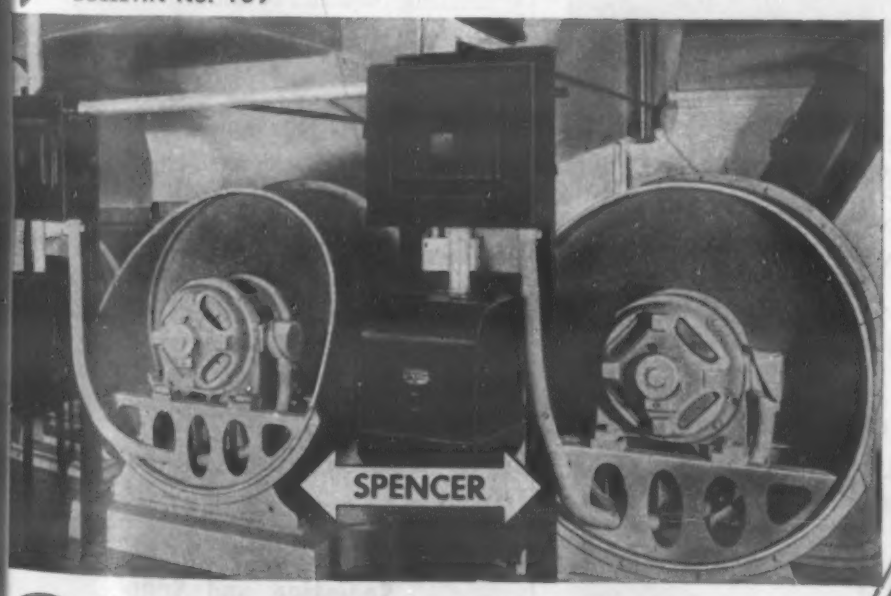
Heat Treating
BULLETIN No. 126





Foundry
BULLETIN No. 112

Gas Booster
BULLETIN No. 109



Blowing
BULLETIN No. 127

Pneumatic Tube
BULLETIN No. 104

3596

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Gas Generator Tube . . .

30% Cr — 20% Ni

This tube is made up of three centrifugally cast sections, each about 9 feet long and welded together to make a total length of some 27 feet. The wall thickness is ½ inch.

Centrifugally cast alloy steel is exceptionally uniform, strong and close-grained. More and more it is being used for process work where high strength and safety coupled with heat or corrosion resistance are required. And a big share of the industry's centrifugal casting tonnage is coming from the same Duraloy high alloy foundry that produced this gas generator tube.

How about making Duraloy your source of supply for chrome iron, chrome nickel or nickel chrome castings — centrifugal or static? We have the experience.

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News Digest

recently was made by *Standard Steel Corp.*, Los Angeles, Calif. H. W. Harrigan, general manager of the division, will become Eastern manager of Standard Steel. J. A. Boyd, chief engineer for Hersey, is moving to Los Angeles to assume a similar position, assisting R. J. Love, vice president in charge of engineering for Standard Steel.

Metalwash Machinery Corp., formerly of 149 Shaw Ave., Irvington, N. J., has announced the opening of its new plant at North Ave., Elizabeth, N. J.

Completion of expanded mill facilities by the *Riverside Metal Co.*, Riverside, N. J., now enables the company to offer wire as small as 0.005 in. in dia. and rods as large as 4¾ in.

Tube Turns of Canada, Ltd., a subsidiary of *Tube Turns, Inc.*, Louisville, Ky., is completing construction of a new plant on Colborne St. in Chatham, Ont., Canada. The company will manufacture Tube-Turn welding fittings, and should be ready for operations within three months.

A national industrial arts awards program for junior and senior high school students is being sponsored by the *Ford Motor Co.*, Dearborn, Mich. The new program will be a continuation of the Industrial Arts Awards originated three years ago by *Scholastic Magazine*, and will be known as "Ford Motor Company Industrial Arts Awards". Students in industrial arts and vocational classes in all schools, from grades seven through 12, may enter. Information regarding the program may be obtained by addressing inquiries to Industrial Arts Awards, Ford Motor Co., 3000 Schaefer Rd., Dearborn, Mich.

Three judges have been appointed for the Cooper Alloy essay contest on "Applications for Cast Stainless Steel in the Chemical Industry". They are T. C. Du Mond, editor of MATERIALS & METHODS; E. C. Fetter, managing editor of *Chemical Engineering;* and D. W. Talbott, vice president and general manager of Cooper Alloy. The contest is scheduled to close May 1, 1950. Full details are available from the Contest Editor, *Cooper Alloy Foundry Co.*, Hillside 5, N. J.

NEWS OF

Societies and Schools

The *Society of Plastics Engineers* recently elected new officers for the coming year. They include: president—C. Todd Clark, director of the Plastics Div. of the F. Burkart Manufacturing Co., who succeeds Mario J. Petretti; vice president—Islyn Thomas, president of Thomas Manufacturing Corp.; secretary—Robert L. Davis, sales engineer for the Continental Can Co.; and treasurer—W. O. Bracken, of the Hercules Powder Co.

Frank G. Breyer, member of the con-

If ABRASION is Your Problem...

look to NI-HARD for Your Answer

ONE OF THE HARDEST commercial products of the iron foundry is a *nickel-chromium white cast iron* trade-named "NI-HARD*".

HARDNESS RANGE

Its Brinell hardness ranges from 550 to 650 when sand cast, and 600 to 725 when chill cast.

This extreme hardness . . . at the moderate price of NI-HARD . . . provides abrasion resistance at lowest ultimate cost.

STRUCTURE

Unlike other cast irons . . . NI-HARD comprises a multitude of hard carbides firmly embedded in a matrix which is as hard as fully hardened steel. NI-HARD is unmachinable except in special cases. Finishing requirements are met by grinding or the use of cast-in-place machinable inserts.

PERFORMANCE

NI-HARD develops abrasion resistance two to three times better than that of unalloyed white iron. Therefore NI-HARD can economically replace white iron.

NI-HARD lasts one and one-half to two times as long as austenitic manganese or carbon steels, under conditions involving only moderate impact. Chill cast parts are stronger and more abrasion-resistant than comparable sand castings.

STRESS RELIEF

The strength and toughness of NI-HARD castings are increased fifty to eighty per cent, without loss in hardness or abrasion resistance, by a stress relieving treatment at 400-450°F. User experience has demonstrated the merit of specifying this treatment.

APPLICATIONS

Applications include: grinding balls, ball and rod mill liners, slurry pump parts, flotation impellers, piping, scoop lips, classifier shoes, roll heads, pulverizer rings, chutes and hopper liners, muller tires, plows, pug mill knives, clay augers. Also coke grizzly discs, crusher rolls, coal mine pumps, dredge pump impellers, liners, rings and sleeves. Also industrial food grinding burrs and attrition mill plates.

AVAILABILITY

Try NI-HARD wherever you encounter severe abrasion. See for yourself how its remarkable properties minimize replacements and repairs.

Authorized foundries throughout the country readily produce NI-HARD castings in all forms and shapes common to the iron and steel foundry.

INFORMATION AVAILABLE

Full information is yours for the asking. Write for the booklets, "Engineering Properties and Applications of NI-HARD", and, "Buyers Guide for NI-HARD Castings."

*Reg. U. S. Pat. Off.

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TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET
NEW YORK 5, N.Y.

METAL finishers using Oakite Compound No. 33 say this new cleaning-phosphating material is just what they've been looking for: a solvent-acid combination that *in one operation* removes oil and rust and conditions the metal surface for painting.

Oakite Compound No. 33 is great for removing rust, heat scale, other oxides, carbon smut, soldering and welding residues, identification inks and oil from steel, cast iron, aluminum sheet and castings.

Oakite Compound No. 33 is a great soak cleaner for metal parts of moderate size; and great for hand-swabbing on large parts like cabinets, desks, doors, tractors and truck cabs.

Oakite Compound No. 33 saves money; frequently eliminating separate pickling operations on moderately rusty steel. It produces splendid paint adhesion.

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ALSO *ask about Oakite procedures for:*

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News Digest

sulting metallurgical and chemical engineering firm of Singmaster & Breyer, was voted honorary membership in the American Institute of Chemists due to his important applications of chemistry and engineering in industry.

During the annual meeting of the *Aluminum Association* officers for the ensuing year were elected. They include: president—R. S. Reynolds, Jr., Reynolds Metals Co.; vice presidents—E. G. Grundstrom, Advance Aluminum Castings Corp.; M. E. Rosenthal, United Smelting & Aluminum Co., Inc.; and George N. Wright, John Harsh Bronze & Foundry Co. A. V. Davis, Aluminum Co. of America, was re-elected chairman of the board, and Donald M. White was re-appointed secretary and treasurer. Three directors-at-large were elected to serve for three-year terms: A. P. Cochran, Cochran Foil Co., Inc.; D. A. Rhoads, Kaiser Aluminum & Chemical Corp.; and R. J. Boshirt, Bohn Aluminum & Brass Corp.

The *American Society of Body Engineers* recently elected the following officers for the ensuing year: president—Lynn A. Fill, chief engineer of Motor Products Corp.; vice president—Charles L. Waterhouse, manager of styling, Ford Motor Co.; secretary—James L. Berridge, design engineer of Woodall Industries; and treasurer—Edward L. Pangborn, design engineer of Chrysler Corp.

Dr. John W. Vanderbilt, consulting geologist, has been named president of the *Colorado School of Mines*. He succeeds Dr. Ben H. Parker, who has submitted his resignation, to take effect Apr. 1.

The *Institute of the Aeronautical Sciences* elected James H. Kindelberger, chairman of the board and chief executive officer of North American Aviation, Inc., as its 1950 president. New vice presidents named were Wellwood E. Beall, vice president-Engineering & Sales, Boeing Airplane Co.; William K. Ebel, vice president in charge of engineering, Canadair, Ltd.; William Littlewood, vice president of engineering, American Airlines, Inc.; and E. G. Stout, assistant to the chief engineer, Consolidated Vultee Aircraft Corp. The new treasurer is Elmer A. Sperry, Jr., vice president and treasurer of Sperry Products, Inc.

Complete information on the *American Die Casting Institute* Annual Doehler Award, for outstanding contributions to the advancement of the die casting industry and process, may be obtained from the Institute by writing to the Award Committee, American Die Casting Institute, 366 Madison Ave., New York 17, N. Y. Any individual, group of individuals, technical or scientific society or committee shall be eligible whether or not engaged in the die casting business and whether or not in the employ of a member of the Institute. Nominations for this year's Award should be received by the Committee no later than Apr. 30.

Stuart's ThredKuT

D. A. STUART'S THREDKUT straight, or in rich blend, provides fine finish on tough, stringy materials because its high sulphur content gives it excellent anti-weld characteristics.

In long dilutions THREDKUT delivers long tool life and outstanding performance at low cost on free cutting, high speed operations.

THREDKUT'S exceptionally broad range of usefulness makes it cost less than "cheaper" products in the majority of cases and often eliminates the need for several different types of oils. When it comes to *performance* on the jobs within its range, *none can best it!* Write for details and literature.

100% of All Metal Cutting Jobs Can Be Done at Lower Cost with D. A. Stuart's Wise Economy Plan *Ask about it!*

OUR 85th YEAR

D. A. Stuart Oil Co.

2745 South Troy Street, Chicago 23, Illinois

The sky's the limit—

when you buy Stainless Steel Bars from us

U·S·S Stainless Steel Bars are available in the widest, most complete range of sizes, shapes and grades anywhere obtainable.

THERE's no limiting "standard range of sizes" to restrict your choice when you come to us for Stainless Steel Bars. Here you can get what you want from an almost unlimited source of supply. Here you'll find a complete selection of sizes, shapes and grades, even those usually considered unavailable — rounds, squares, octagons and flats . . . structural shapes, angles and channels— from very small sizes to dimensions approaching and often equalling the maximum available in structural carbon steel.

What does this unusual size and section range mean to you? It means more flexibility and freedom for your designers . . . added economy in your production lines . . . greater speed and convenience in purchasing . . . greater sales appeal in your finished product.

Available, too, in many special sections

You can eliminate much of the expensive machining required to make irregular-shaped parts by taking advantage of the great variety of special sections in which U·S·S Stainless Steel Bars are available. Our mills have passes for an unusually broad range of sections for special applications. We can cut new rolls for others if your requirements justify the need.

If you want stainless steel bars of highest quality, your most dependable source of supply is our district office nearest you.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO · CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH & CHICAGO
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
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UNITED STATES STEEL

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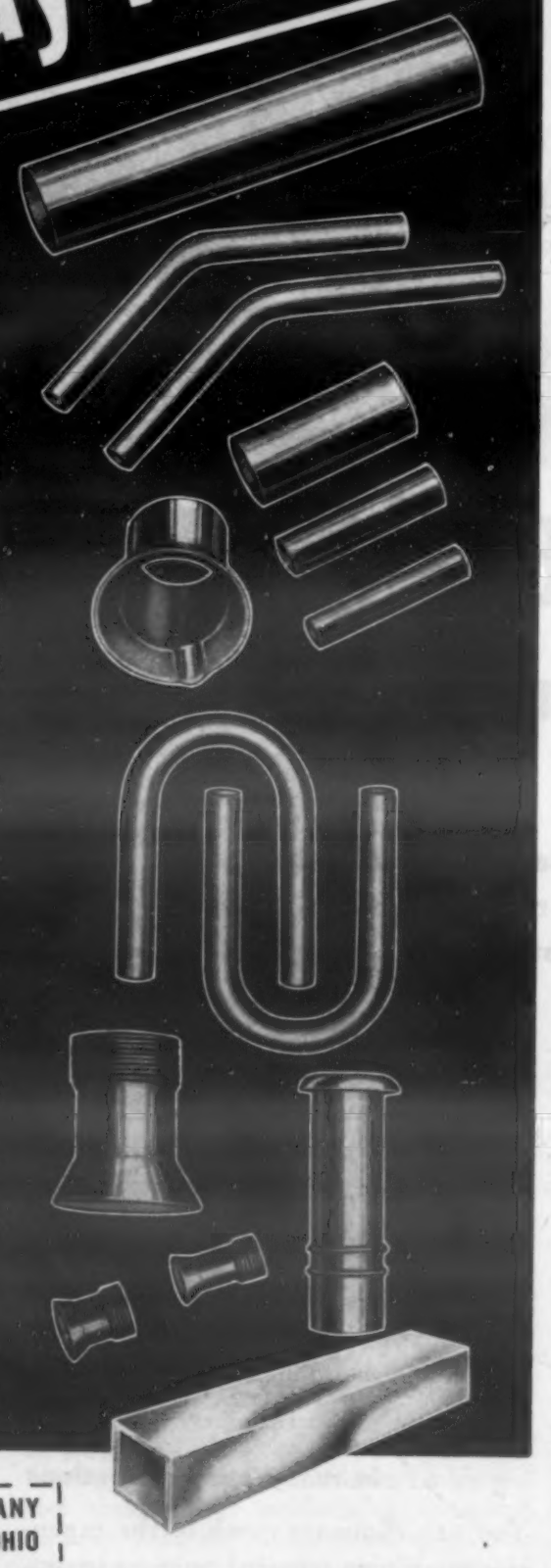

If you are in the market for high performance steel tubing it will more than pay you to check with Brainard — one of America's leading producers of electric welded mechanical tubing.

Brainard tubing is available in either the round or square, in sizes from ½" O.D. to 4-inch O.D. inclusive. Wall thicknesses of from .025 to .165.

TUBING DIVISION, BRAINARD STEEL COMPANY
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Title _____

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TUBING DIVISION

BRAINARD STEEL COMPANY

2333 LARCHMONT AVE., WARREN, OHIO

Meetings and Expositions

SOCIETY OF THE PLASTICS INDUSTRY, national meeting. Chicago, Ill. Mar. 28-31, 1950.

ASSOCIATION OF IRON & STEEL ENGINEERS, spring meeting. Birmingham, Ala. Apr. 3-4, 1950.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference and exhibition. St. Louis, Mo. Apr. 4-7, 1950.

CHICAGO TECHNICAL SOCIETIES COUNCIL, annual conference and production show. Chicago, Ill. Apr. 4-8, 1950.

ELECTRIC WELDING CONFERENCE. Detroit, Mich. Apr. 5-7, 1950.

MIDWEST POWER CONFERENCE. Chicago, Ill. Apr. 5-7, 1950.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth, Blast Furnace, Coke Oven and Raw Materials conferences. Cincinnati, Ohio. Apr. 10-12, 1950.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Philadelphia, Pa. Apr. 10-14, 1950.

AMERICAN ZINC INSTITUTE, annual meeting. St. Louis, Mo. Apr. 11-12, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Washington, D. C. Apr. 12-14, 1950.

NATIONAL PETROLEUM ASSOCIATION, annual meeting. Cleveland, Ohio. Apr. 12-14, 1950.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic and air transport meeting. New York, N. Y. Apr. 17-19, 1950.

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting. Los Angeles, Calif. Apr. 19-21, 1950.

ELECTROCHEMICAL SOCIETY, spring meeting. Cleveland, Ohio. Apr. 19-22, 1950.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div., New England regional conference. Providence, R. I. Apr. 21-22, 1950.

PACKAGING MACHINERY MANUFACTURERS INSTITUTE, semi-annual meeting. Chicago, Ill. April 24, 1950.

AMERICAN CERAMIC SOCIETY, annual meeting. New York, N. Y. Apr. 24-26, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Process Industries Div. conference. Pittsburgh, Pa. Apr. 24-26, 1950.

AMERICAN MANAGEMENT ASSOCIATION, annual packaging exposition. Chicago, Ill. Apr. 24-27, 1950.

MACHINE TOOL ELECTRIFICATION FORUM. Sponsored by Westinghouse Electric Corp. Buffalo, N. Y. Apr. 25-26, 1950.

METAL POWDER ASSOCIATION, annual meeting and exhibit. Detroit, Mich. Apr. 25-26, 1950.

Showing Stainless Food Equipment Company's standard Back Bar Equipment which is fabricated by Wales Hole Punching and Notching Equipment.

A typical setup of Wales Type "BL" Hole Punching Units in a press brake at Stainless Food Equipment Company.

● Once metal fabricators start to use money-saving, time-saving Wales Equipment, they invariably change over all their hole punching and notching operations to standardize on this tooling method. There is no substitution for experience to fully appreciate the patented advantages of Wales Hole Punching and Notching Equipment.

Write today for your copies of the Wales fully-illustrated, functionally-colored catalogs BL and N that give the inside story of Wales Equipment that has revolutionized tooling practice.

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YOU GET POSITIVE CORROSION RESISTANCE ON ALL!

Tanks 10 ft. in diameter, 12 ft. deep—or pipe fittings no larger than your thumb. Every piece of process equipment in your plant can be made *positively* corrosion resistant for longer service life, lower maintenance costs. HAVEG, the strong, lightweight molded material, resists chemical action *through its entire mass.* Not just a lining or coating, its performance is not affected by surface gouges or abrasion.

We're sure HAVEG can help you increase equipment life—so sure that we ask you to try it. Send for samples or install a test piece. Meanwhile, for detailed engineering and application data, write for Bulletin F-5, today.

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BOOK REVIEWS

Rare Metals

RARER METALS. *By Jack de Ment, H. C. Dake, E. R. Roberts and R. Campbell Williams. Published by Temple Press, Ltd., London, 1949. Cloth, 5¾ by 8⅞ in., 345 pages. Price 25s.*

This is a concise and readable book which describes briefly the mineralogy, chemistry, physics and technology of some of our less familiar metals.

A compilation of basic data, it has been arranged with both the student and the busy professional engineer in mind. For titanium, for instance, the authors discuss the history of the element, its occurrence in ores, physical properties, chemical properties, important compounds, methods of extraction from ores, technology of the metal and its compounds, and methods of chemical analysis—all in the space of 15 pages.

The metals covered in this book are: beryllium, gallium, indium, thallium, germanium, titanium, zirconium, hafnium, thorium, vanadium, columbium, tantalum, molybdenum, tungsten, uranium, selenium, tellurium, platinum, palladium, rhodium, iridium, osmium, ruthenium, lithium, rubidium, caesium, calcium, barium, rhenium and boron.

Chief difference between this English edition and its American counterpart is the addition of the material on the rarer alkali metals, the alkaline earth metals, boron and rhenium.

Electrodeposition of Metals

PRINCIPLES OF ELECTROPLATING AND ELECTROFORMING (ELECTROTYPING). REVISED THIRD EDITION. *By William Blum and George B. Hogaboom. Published by McGraw-Hill Book Co., New York 18, N. Y., 1949. Cloth, 6¼ by 9¼ in., 455 pages. Price $6.00.*

The third edition of this work, first published in 1924, takes cognizance of the revolutionary changes that have occurred in the electroplating industry during the past few decades. The authors have not tried to include the details of all these developments, however. Instead they have made an effort to summarize and digest the available knowledge of the theory and practice of electroplating and to present it in a form that will benefit both the platers and chemists.

The book develops according to a logical pattern, starting with brief chapters on engineering units and principles of chemistry designed to make the text self-contained. From there the authors proceed to the principles of electricity and electrochemistry, factors that govern the character and distribution of electrodeposits, and the selection, specification and inspection of electrodeposits. A separate chapter is devoted to methods of analyzing plating solutions. Several successive chapters deal with preparation for electroplating and electroforming, and the tanks and electrical equipment required.

The individual plating baths available are discussed in a series of 11 chapters in which the various metals are grouped together according to their position in the periodic table. For each metal, the applications and bath selection factors are discussed; next, operating details are given for each bath of major importance. This specific application data is completed by a final chapter on alloy deposition, with particular attention to brass plating.

Other New Books

THE TRANSURANIUM ELEMENTS—RESEARCH PAPERS. PARTS I AND II. *Edited by Glenn T. Seaborg, Joseph J. Katz and Winston M. Manning. Published by McGraw-Hill Book Co., New York 18, N. Y., 1949. Cloth, 6¼ by 9¼ in., (Part I—859 pages, Part II—874 pages). Price $15.00 (not sold separately).* Consists of 162 original research papers dealing with the transuranium elements and cognate topics. Coven investigations begun as early as 1940. Designed to serve as foundation for United States atomic energy program.

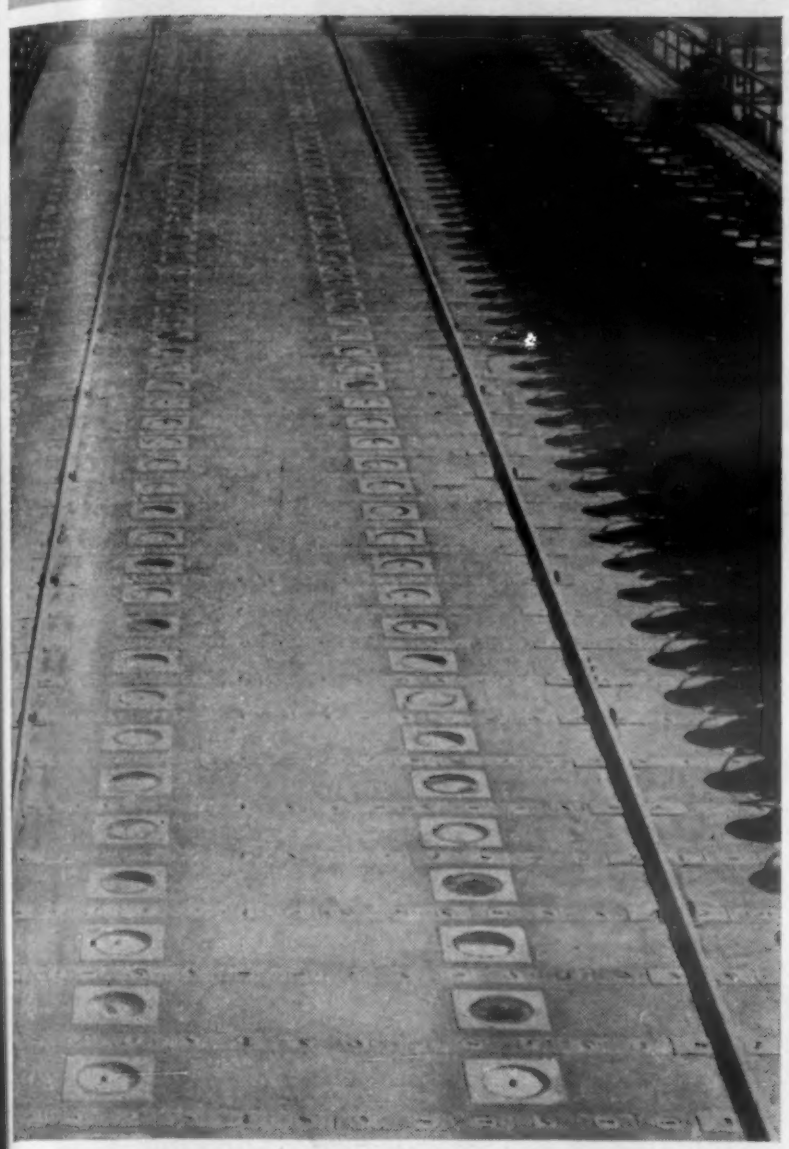
36TH ANNUAL PROCEEDINGS. *Edited by Gustaf Soderberg. Published by the American Electroplaters' Society, Jenkintown, Pa., 1949. Cloth 6¼ by 9¼ in., 272 pages. Price $5.00.* Contains the proceedings of the 36th annual convention of the American Electroplaters' Society, which was held June 28 to July 1, 1949, in Milwaukee, Wis.

SOUND ABSORBING MATERIALS. *By C. Zwikker and C. W. Kosten. Published by Elsevier Publishing Co., Inc., New York 3, N. Y., 1949. Cloth, 6¼ by 9¾ in., 174 pages. Price $3.00.* More detailed information concerning efficient sound absorption, sound insulation, and the sound absorption coefficient of the various materials on the market today is presented.

SYMPOSIUM ON METALLOGRAPHY IN COLOR (1948). *Published by the American Society for Testing Materials, Philadelphia 3, Pa., 1949. Paper, 6 by 9 in., 64 pages, plus 10 insert color plates. Price $4.50; cloth cover, $5.15.* This Special Technical Publication No. 86 contains the papers and discussions of the symposium on metallography in color, presented at the 51st annual meeting of the American Society for Testing Materials, held in Detroit, June 21, 1948.

GRINDING PRACTICE. REVISED THIRD EDITION. *By Fred H. Colvin and Frank A. Stanley. Published by McGraw-Hill Book Co., New York 18, N. Y., 1950. Cloth, 6¼ by 9¼ in., 419 pages. Price $3.75.* Typical machines, methods used in various phases of grinding practice, hints, cautions, illustrations, step-by-step instructions, etc. are included in this completely revised third edition.

Here's more proof that Lumnite* Concrete is the ADAPTABLE Refractory!



Paving for coke oven battery, Clairton By-product Coke Works, Carnegie-Illinois Steel Corp., Clairton, Pa. Lumnite Refractory Concrete withstands changing temperatures, resists corrosion and its one-piece, monolithic construction remains smooth, outlasting other paving materials.

Here's Where Lumnite Refractory Concrete Cuts Costs, Saves Time in Coke Plants

Coke plant operators, like many others, are finding more and more time- and money-saving uses for adaptable Lumnite Refractory Concrete. No other refractory material combines Lumnite's refractory properties with such convenience and flexibility of use. Refractory concrete is easily placed in any size, shape or form without skilled workmen. The large number of successful Lumnite installations now in use offers adequate proof of their excellent service records.

WHERE USED: Lumnite Refractory Concrete may be cast in place in coke plants for such uses as: coke oven paving, base pads and flues that last longer, yet cost less to construct and maintain. Refractory Concrete is also useful for many other installations subject to heat, corrosion and severe thermal shock such as backwalls for quenching cars. And, in addition, Lumnite is excellent for precast special shapes—door linings, baffles, blocks for inspection and charging holes, lintels, arches, arch slabs, riser pipe linings and seat blocks, gas gun blocks, caps for top of coke oven, and plugs to fit special openings.

SAVES TIME, CUTS COSTS: Refractory Concrete made with Lumnite calcium-aluminate cement and selected aggregates may be cast in place in exact sizes, shapes and thicknesses desired. Monolithic construction gives maximum durability, reduces outage time for repairs. When repairs are needed, they may be made quickly and easily overnight, because Lumnite reaches service strength in 24 hours or less. Always keep a supply of Lumnite cement on hand. Whether your plant calls for coke ovens or not, you may profit from the properties of time- and cost-saving Lumnite. Write today for further information to Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, New York.

Base-slab and waste heat flue of heat-resistant concrete made with Lumnite. Withstands heat, and waste gases of burning coke. National Tube Co., Lorain, Ohio.

Coke side of Refractory Concrete door lining in service over ten years when this photo was taken. That's durability! Laclede Gas Light Co., St. Louis, Mo.

SPECIFY CASTABLE REFRACTORIES MADE WITH LUMNITE

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

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EDITORIAL

Plastics Progress

During the last few days of this month, members of the plastics industry will gather in Chicago to see the latest in plastics products and production methods. Perhaps, then, this is as good a time as any to pay tribute to the progress made by the industry as a whole.

There is still a vast lack of information on the part of the public where plastics is concerned. The myriad of complex technical designations does not help the situation any. However, progress is being made in spite of these obvious handicaps.

In the first place, the glamour once associated with the word plastics has largely disappeared. Now, in most cases plastics are used only when they would seem to offer some definite advantage, to both the product manufacturer and the ultimate consumer.

Secondly, forward-seeing raw material manufacturers are doing everything possible to prevent the misapplication of their resins. Some make a standing offer to test under both laboratory and service conditions products under consideration. An adverse report on a potential use will carry with it recommendations as to whether or not some other plastics material will serve better, if indeed plastics will meet service requirements.

A third measure is the informative labeling program devised and fostered by plastics trade associations. The idea behind this program is that if every one involved in the manufacture, sale and use of a plastics product is told what the product can and cannot do, there will be much less chance of all plastics being classed as no good. Too many consumers still consider plastics as inferior materials because they remember dishes or strainers made of plastics that turned into a limp wad of goo when subjected to boiling dish water.

Still further evidence of the progress plastics have made is in the fact that these materials are now competing with other materials on the basis of their engineering properties. In an article in this issue, there are given several examples of how plastics parts are serving well on engineering applications, and why. There are hundreds of other cases where plastics are being used because they have properties superior to those of any other competitive materials. This situation signals the end of an era during which plastics were most often considered substitutes rather than materials which should be used on their own merits.

If the plastics industry continues to advance in this direction, and we see no reason why it should not, we and everyone else associated in any way with plastics shall have justification for pride in a task well done.

T. C. Du Mond
Editor